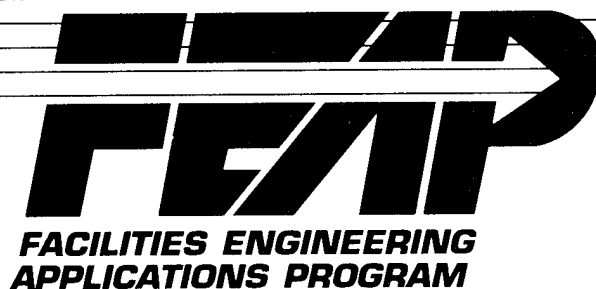
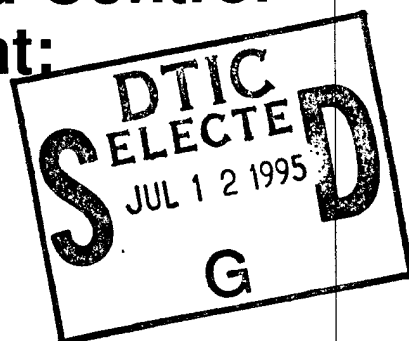


FEAP-TR-FE-95/12
May 1995



**TECHNICAL
REPORT**

The Use of Firm Neutral Data Standard Communications Protocol in a Utility and Energy Monitoring and Control System Environment: A Demonstration

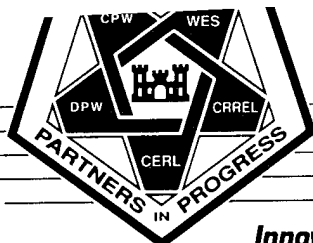


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Innovative Ideas for the Operation, Maintenance, & Repair of Army Facilities

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Foreword

This study was conducted for Headquarters, U.S. Army, Europe (HQ USAREUR) under reimbursable project "Karlsruhe FND/UEMCS Demonstration," and the U.S. Army Center for Public Works (USACPW) under the Facilities Engineering Application Program (FEAP) Work Unit FE-FC4, "Standard DDC Interface in USAREUR." The technical monitors were Jeffrey Mitchell, AEAEN-EH, and Christopher Irby, CECPW-FU-M.

The work was performed by the Energy and Utility Systems Division (FE) of the Infrastructure Laboratory (FL), U.S. Army Construction Engineering Research Laboratories (USACERL). Special appreciation is expressed to the Mandatory Center of Expertise, Huntsville Division, U.S. Army Corps of Engineers, Huntsville, AL for their assistance throughout this project. Donald F. Fournier is Acting Chief, CECER-FE, and Dr. David M. Joncich is Acting Chief, CECER-FL. The USACERL technical editor was William J. Wolfe, Information Management Office.

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Contents

SF298	1
Foreword	2
1 Introduction	5
Background	
Objective	
Approach	
Mode of Technology Transfer	
2 EMCS/UEMCS and DDC Use in U.S. Army Facilities	7
Early Army EMCS	
Direct Digital Controls	
Modern Army EMCS/UEMCS	
3 Standard Communication Protocols	11
ISO/OSI Standard Reference Model	
Types of Standard Communication Protocols	
Firm Neutral Data Protocol	
4 Karlsruhe UEMCS/FND System Demonstration Project	18
Project Development	
UEMCS Central Station	
Island System	
Detached Island System	
System Testing	
5 Other FND Projects	26
6 Conclusions and Recommendations	28
References	29
Appendix A: Corps of Engineers Guide Specifications (CEGS) 13952, "OCONUS Direct Control Utility and Energy Monitoring and Control System"	30

Distribution

1 Introduction

Background

A typical U.S. Army, Europe (USAREUR) installation has a complex infrastructure consisting of multiple buildings and utility systems that may include a variety of mechanical and electrical subsystems. At many USAREUR installations, the operation of these building and utility systems is controlled and managed by Utility and Energy Monitoring and Control Systems (UEMCSs). A modern UEMCS uses microprocessors, associated peripherals, instrumentation, control equipment, and software programs to provide both local and supervisory control of building and utility systems. UEMCS for USAREUR applications is typically configured as a distributed system, with local control and monitoring functions performed by standalone microprocessor-based controllers. The local control equipment located at multiple sites within one or more military installations is usually connected to a central supervisory system, available for monitoring and control of heating, ventilation, and air-conditioning (HVAC) systems, utility system usage and demand, and utility system maintenance planning and management.

The commercially available hardware/software systems used to create modern UEMCSs are commonly referred to as direct digital control (DDC) systems. DDC systems are readily available from multiple vendors, and each vendor's DDC system typically includes an array of microprocessor-based local controllers and a personal computer-based central station for supervisory monitoring and control of the system. A DDC system operates by exchanging digital data between all the individual microprocessors within the system using complex, proprietary communication protocols. As a result, different vendors' DDC systems normally are not communications compatible. Consequently, integration of different manufacturers' DDC systems, which may be installed on individual buildings or utility systems at a USAREUR installation, into a single UEMCS has not been practical.

The German Federal Ministry of Construction, in cooperation with the Ministry of Finance, has developed a standard interface that permits proprietary DDC systems to be interconnected. This interface, called *Firmenneutrale Datauebertragugssystem* (translated as "Firm Neutral Data," abbreviated "FND"), requires each DDC manufacturer to develop a hardware/software gateway for their system's central

station. This gateway translates digital communications transmitted from that system to the standard FND format. The FND technology may provide a standard method for integrating multiple vendor DDC systems into a single, fully functional UEMCS, yet research is required to test and evaluate the applicability of the FND interface to UEMCS at USAREUR installations.

Objective

The objective of this research was to demonstrate the use of FND to integrate multiple-vendor DDC systems into a single operating UEMCS and to evaluate the performance of the FND-based UEMCS to ensure that it supports all the required functions defined in Corps of Engineers Guide Specifications (CEGS) 13952, "OCONUS Direct Control Utility and Energy Monitoring and Control System," Sections 9-15 (U.S. Army Corps of Engineers Huntsville Division, Huntsville, AL, September 1990) (Appendix A).

Approach

A team of Corps of Engineers and other Army experts developed demonstration project requirements and identified a demonstration site. The design for a multi-vendor UEMCS using FND was developed for the site using CEGS 13952 and a standard FND specification. A contract was awarded by the USAREUR Contracting Center, Frankfurt, to install the UEMCS/FND system at the demonstration site. Once the contractor completed installation of the UEMCS/FND system, system performance was evaluated by the same Army team that originally developed the project requirements to verify that the UEMCS/FND system supported basic UEMCS functions described in CEGS 13952, including:

- Commands from the UEMCS central station to a DDC station
- Responses from the DDC stations to a command
- Unsolicited messages, such as alarms, from an DDC station to the central station
- Acknowledgements (replies) from the central station to the DDC station for each unsolicited message.

Mode of Technology Transfer

The results of this demonstration project are being used to revise Corps of Engineers Guide Specification (CEGS) 13952, "OCONUS Direct Control Utility and Energy Monitoring and Control System (UEMCS)" to include the use of FND.

2 EMCS/UEMCS and DDC Use in U.S. Army Facilities

Early Army EMCS

In the 1970s, the Army began using Energy Management and Control Systems (EMCSs) as part of its effort to implement effective base-wide energy conservation programs at its installations. These early EMCSs allowed installation energy managers to collect and analyze building energy systems data and to exercise limited supervisory control of building HVAC systems.

Figure 1 shows how early EMCS equipment included a central station interfaced to intelligent Field Interface Devices (FIDs) and Multiplexers (MUXs). The central

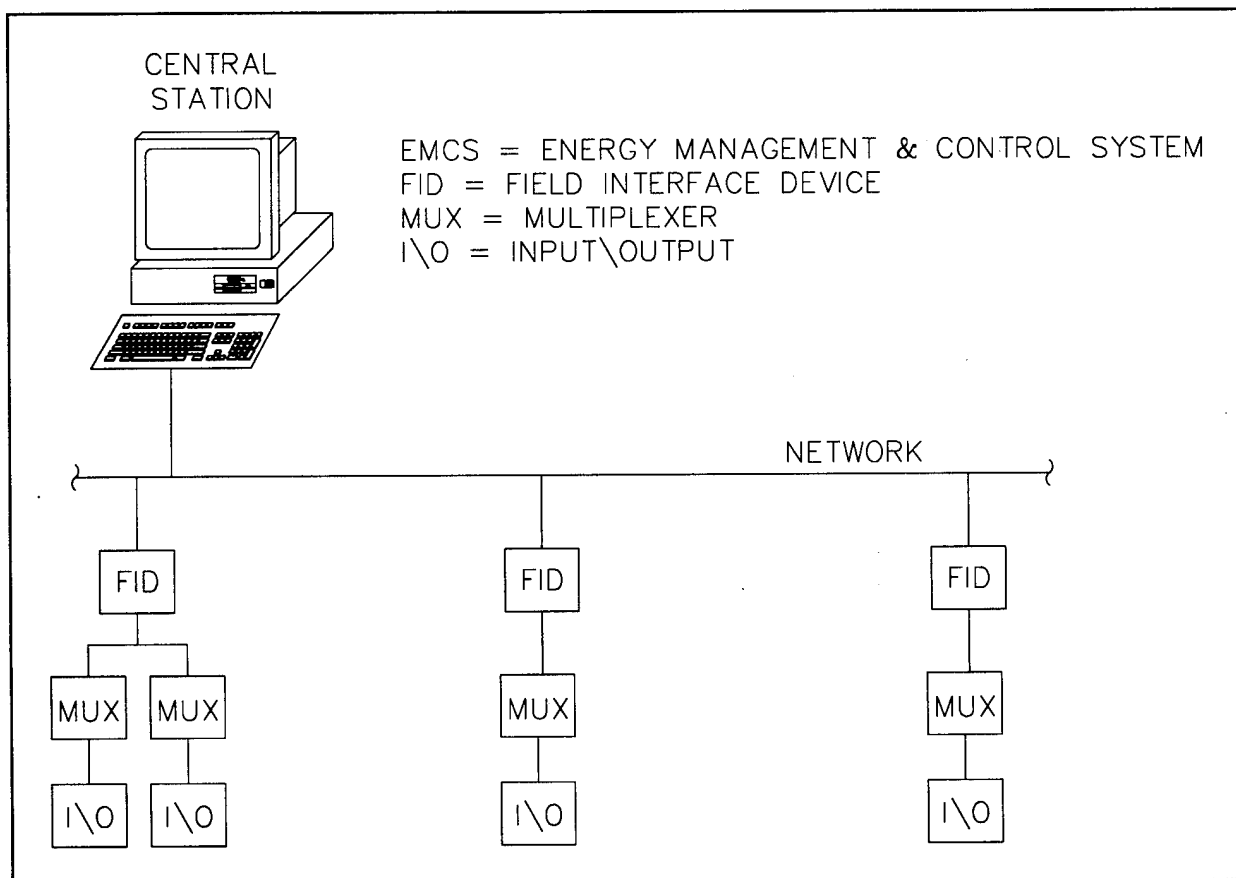


Figure 1. Typical early EMCS.

station was typically a mini-computer, which was used to perform supervisory functions such as monitoring and reporting, and which also permitted operator interaction to turn equipment on and off and to change control setpoints. The FIDs and MUXs provided the hardware input/output (I/O) interface with the existing local building HVAC control systems, which were typically pneumatic. The FIDs and MUXs were installed separately from these local controls. Later, EMCS provided for added functionality at the FID and MUX level including features such as occupied/unoccupied control modes, optimum start-stop, and setpoint reset.

The FIDs and MUXs in an EMCS communicates with the central station using proprietary communication protocols that were developed for each vendor's EMCS. Army EMCSs were typically procured as basewide installations from one supplier. If an installation took this approach, proprietary communication protocols did not pose a large problem except when the need arose to procure replacement components or expand a future system.

Direct Digital Controls

Direct Digital Control (DDC) technology became commercially available in the 1980s. DDC systems are designed to provide *both* supervisory and local control of building and utility systems (Figure 2). Similar to EMCSs, DDC system devices communicate using proprietary protocols.

Limited numbers of DDC systems have been installed in Army facilities. Each DDC system has typically been procured as part of an individual building project. This resulted in several different vendors' DDC systems being installed at one Army installation. The proprietary communication protocols used in these systems makes it difficult to integrate these DDC systems into an existing or new EMCS. If supervisory control is desired at a central location, a central station must typically be added to the central operator's office for each manufacturer's DDC system.

DDC has additional limitations in Army applications. System expansion and repair hardware and software can only be procured via sole source purchases from the original supplier. In cases where sole source upgrades do occur, newer versions of the same manufacturer's software and hardware are often not compatible with equipment installed earlier. In addition, operators must be familiar with each separate system's hardware and software.

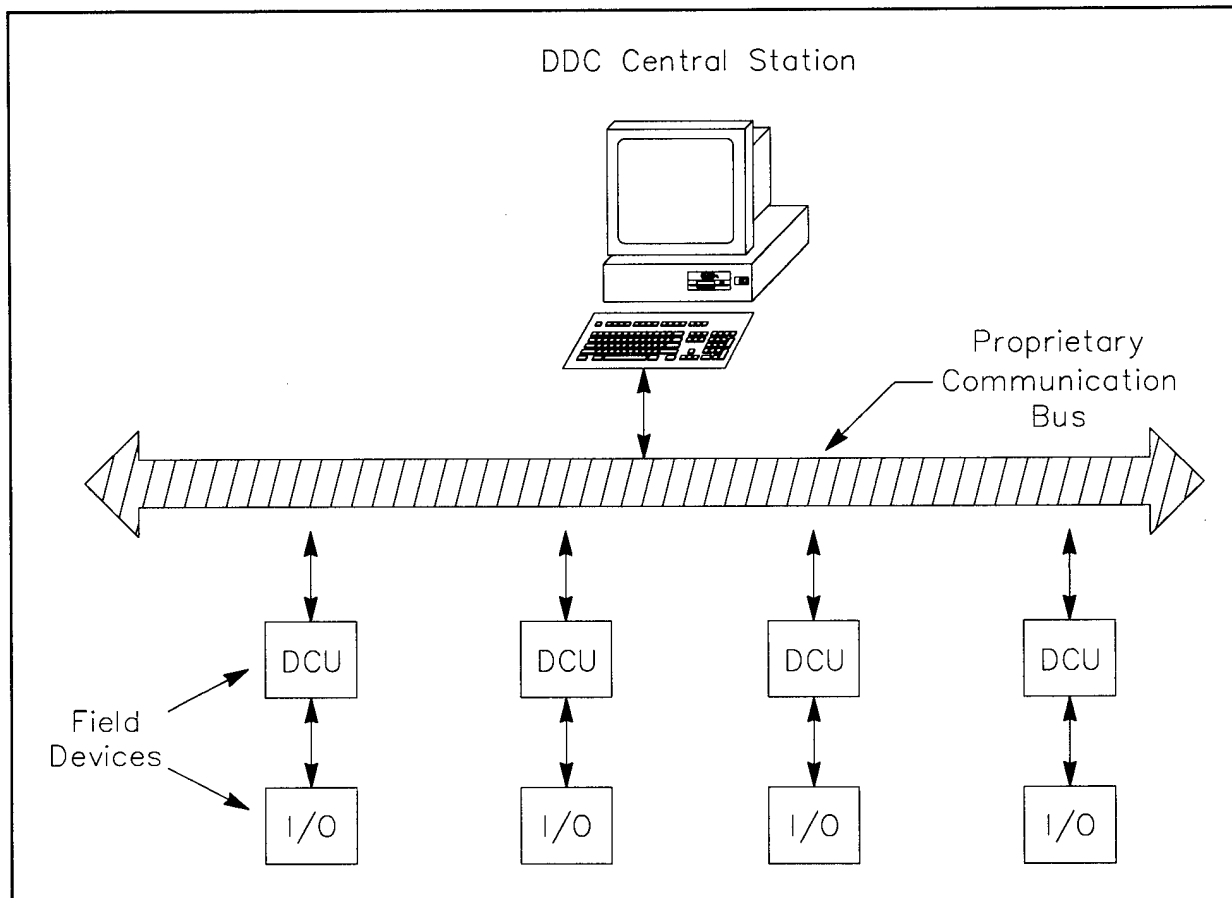


Figure 2. Typical DDC system.

Modern Army EMCS/UEMCS

The Army has a continuing need for reliable local controls for its building and utility systems and for effective basewide energy management systems at its installations. To ensure that its facilities use state-of-the-art, commercially available controls technology, the Army has employed two approaches for the use of DDC technology at its military installations. The first approach applies to installations within the continental United States (CONUS), while the second approach applies to installations outside the continental United States (OCONUS) in USAREUR. The two different approaches were used because the type and complexity of the local building and utility systems are different for continental and overseas facilities.

Within CONUS, the Army continues to have separate supervisory and local control systems. DDC technology is used as the hardware/software basis for EMCS systems that continue to perform supervisory control functions only. The current Army Corps of Engineers guide specifications describe the technology to be used in, and the functions to be performed by modern Army EMCS systems. Army policy states that

local controls for HVAC systems will use the Army standard control systems based on the use of single-loop digital control technology instead of DDC. Army Corps of Engineers Guide Specification (CEGS) 15950, *Heating, Ventilation, and Air-Conditioning HVAC Control Systems* (Huntsville Division, Huntsville, AL, July 1990) describes the standard Army HVAC control systems. DDC is used for local HVAC controls as an exception only.

For OCONUS facilities, the Army has developed a UEMCS that incorporates both local and supervisory control into a single system and that uses DDC technology wherever possible. The Army Corps of Engineers has a current guide specification describing the technology to be used in Army UEMCS systems.

Both EMCS and UEMCS would be more functional within the Army if the DDC technology on which they were based used standard open communication protocols. The lack of interchangeability of the DDC technology between vendors is a serious limitation on the use of the technology.

3 Standard Communication Protocols

ISO/OSI Standard Reference Model

Many efforts are underway to develop standard, open communication protocols for use in automated building control systems. There are several fundamental requirements for establishing an open communications protocol. Communication between different manufacturers' systems can only be achieved by designing the individual hardware and software communication components according to the same communication standard. Each data-handling station must have compatible physical interfaces. Details concerning addressing, handling of transmission errors, format of the data package, and use of the data itself must be agreed on and strictly adhered to by each communication partner.

Considering these necessary attributes, the International Standards Organization (ISO) first addressed the development of standard protocols by developing the Open Systems Interconnection (OSI) standard reference model. This framework defines seven hierarchical layers of control that must be strictly followed to obtain unabridged communication. The function of one layer and how it interfaces to the next layer is specified in the OSI model. Every layer except the seventh offers certain services to the next-higher layer (Figure 3).

The lower four layers of the ISO/OSI model are designated as the "transport system." These layers consist of a: (1) physical layer, (2) data link layer, (3) network layer, and (4) transport layer. Any exchange of messages between communication partners is handled by the transport system. The International Telegraph and Telephone Consultative Committee (CCITT) X.21/X.25 specification is widely applied as the standard to control the transport system of the OSI model.

Within the transport system, the physical layer consists of hardware and regulates transmission media compatibility. The data link layer receives binary information and summarizes it into data packets. This layer also performs primary fault recognition, or error detection, by assuring that point-to-point connections have been properly established. When errors are detected, this layer requests retransmission of the bad frame and assures that the data is redelivered in the proper sequence. The network

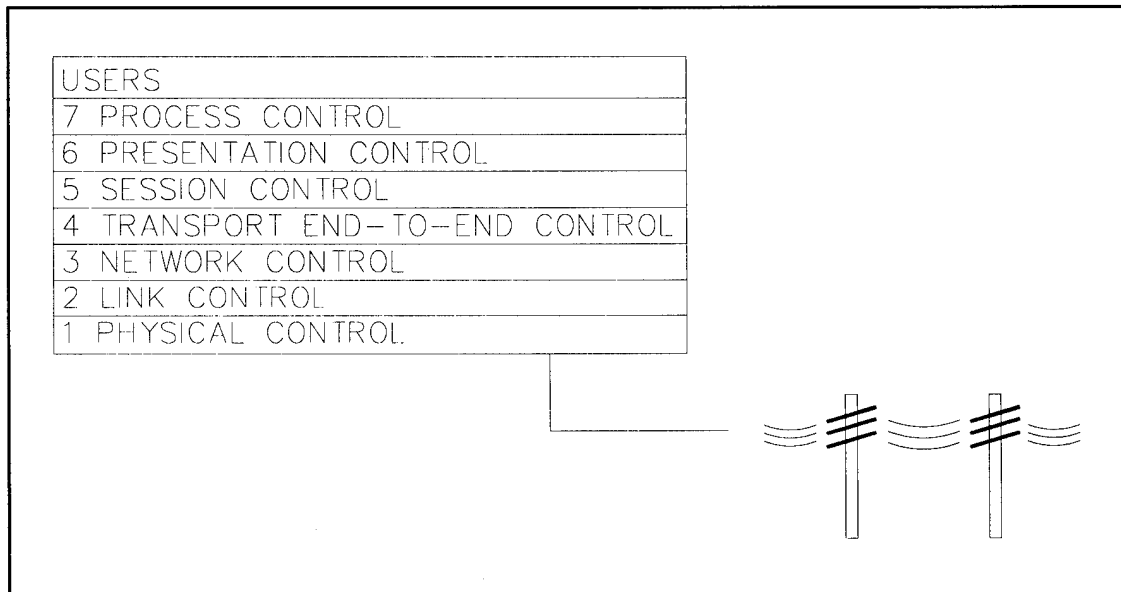


Figure 3. ISO/OSI reference model.

layer determines where the data packets are to be routed, including addressing and node identification. It also regulates the load of data packages being transmitted and prevents interference caused by individual stations transmitting at the same time. The transport layer establishes communication connections between open systems. This layer provides communications flow, preventing data congestion on a network by grouping data frames into either smaller or larger packets, thereby controlling the flow of data between communication entities.

The top three layers of the OSI model are designated as the “user system,” and deal with content of the transmitted message. The user system consists of a: (5) session layer, (6) presentation layer, and (7) application layer.

The session layer provides support for connections between open systems. This layer is dependent on the transport layer for assuring that only one connection is established at a time between open systems. Several connections to open systems can be handled sequentially but not simultaneously. The session layer shields the next two higher layers from connection changes that occur in the transport system. This layer manages the dialogue or two-way flow of data, synchronizing the data interchange between open systems. The presentation layer controls the syntax between systems, ensuring the data is meaningful to both systems. It is in this layer that different syntax are changed. For example, one system may operate using American Standard Code for Information Interchange (ASCII) character code, and another system may use Extended Binary Coded Decimal Interchange Code (EBCDIC). The presentation layer must translate the data appropriately as it passes both directions, providing ASCII to EBCDIC conversion in one direction and EBCDIC to ASCII in the other direction. The

application layer is the highest layer of the OSI model. This layer controls operating system functions as well as application processes and end user interaction. Industry-specific protocols are normally associated with the function of the application layer. Effort to establish a standard protocol for building automation systems would also be defined as "industry specific."

Types of Standard Communication Protocols

Efforts to develop standard open communications protocols fall into two categories: (1) protocols that would allow all control devices of different manufacturers to communicate directly, referred to as "device-to-device" protocols, and (2) protocols that would allow control system central computers, referred to as "central station-to-central station protocols," to communicate.

Device-to-device protocols allow communications between all equipment linked to a communication bus without regard to manufacturer. A standard device-to-device communication protocol would offer maximum flexibility in interfacing, expanding, and repairing DDC systems. Control systems manufacturers do not generally support this approach. They prefer to preserve the integrity of, and responsibility for products within their DDC systems. The use of proprietary protocols assures vendor system integrity. Figure 4 illustrates the concept of interfacing multiple manufacturers' hardware through a device-to-device communications protocol. Such a protocol allows each manufacturer's system to communicate directly with other hosts on the standard communication bus.

Central station-to-central station protocols provide for exchange of information only between the central stations of different vendors DDC systems, while still maintaining the manufacturer's proprietary integrity of all components within the individual DDC systems. This approach is more acceptable to controls vendors and has received

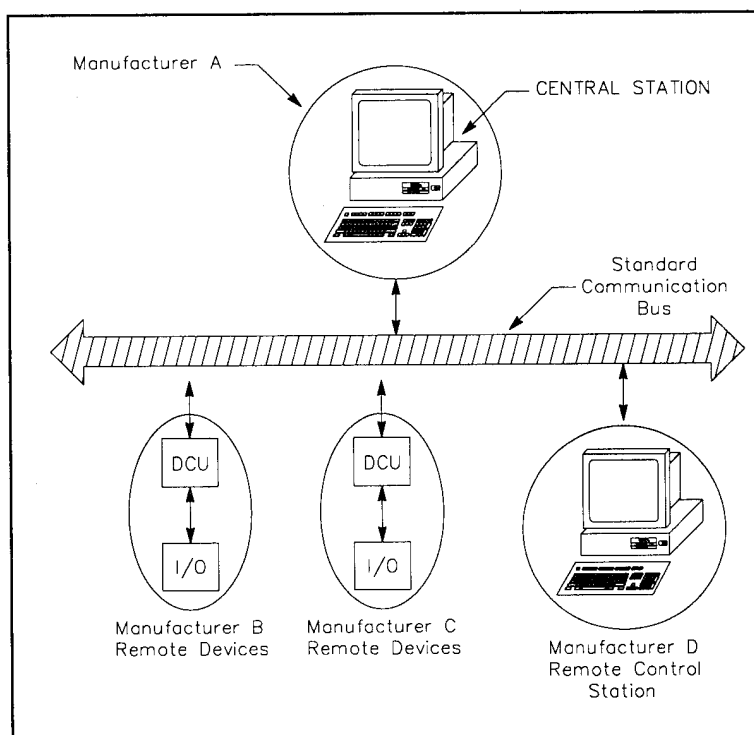


Figure 4. Device-to-device standard protocol.

wider industry support. Figure 5 illustrates the concept of an EMCS using central station-to-central station communications protocol.

Firm Neutral Data Protocol

The German Federal Ministry of Construction, in cooperation with the Ministry of Finance, developed FND standard communication protocol to adhere to the ISO/OSI reference model as a central station-to-central station type protocol. The FND standard communication protocol provided the means to develop an energy management system by interfacing multiple DDC systems of different manufacturers in remote locations to a central energy management office.

The FND protocol specification was published in 1988 by Arbeitskreis Maschinen und Elektrotechniker staatlicher und kommunaler Verwaltungen (translated Working Board for Mechanical and Electrical Engineering for State and Municipal Administration (AMEV)), and was adopted as a DIN standard in 1993. The FND standard defines physical requirements for communications hardware as well as message frame format, data point types, and transmission speed. The FND standard adheres to CCITT standards X.21/X.25 in defining the FND transport system (lower four layers). This standard includes descriptions of approved physical attributes for communication

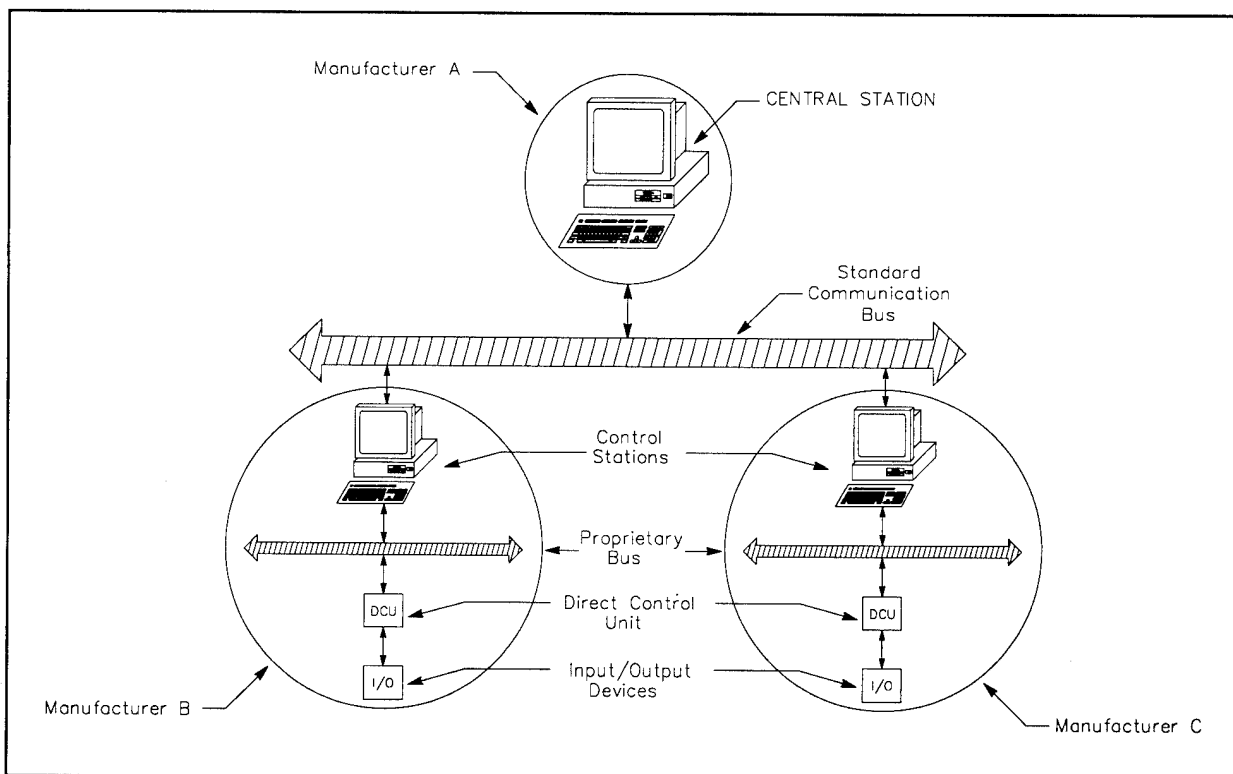


Figure 5. Central station-to-central station standard protocol.

network topologies, communication network interfaces, data point types, data packet frame formats, error detection, and acknowledgements.

Figure 6 represents a generic FND-based UEMCS system. The FND system interfaces DDC control stations from different manufacturers to a central station (abbreviated LZ, for the German word *Leitzentrale*). The central station maintains management and control functions over all interfaced DDC systems.

The individual vendor's DDC systems are referred to as "island systems." The operating station located in this island is referred to as the island control station (abbreviated IZ, for *Inselzentrale*). At a minimum, an island system will consist of an intelligent control panel (called an understation, or UST), an FND standard interface adapter, a network access device, and an operator interface. An island control station is not always a personal computer; the CPU located in a UST can also serve as the control station, with a handheld network interface device (typically a portable personal computer [PC]) used to provide a user interface to the system. The central station communicates with the island stations using FND to obtain data from the island USTs that include UST analog outputs (AO), analog inputs (AI), digital outputs (DO), digital inputs (DI), and pulse accumulator inputs.

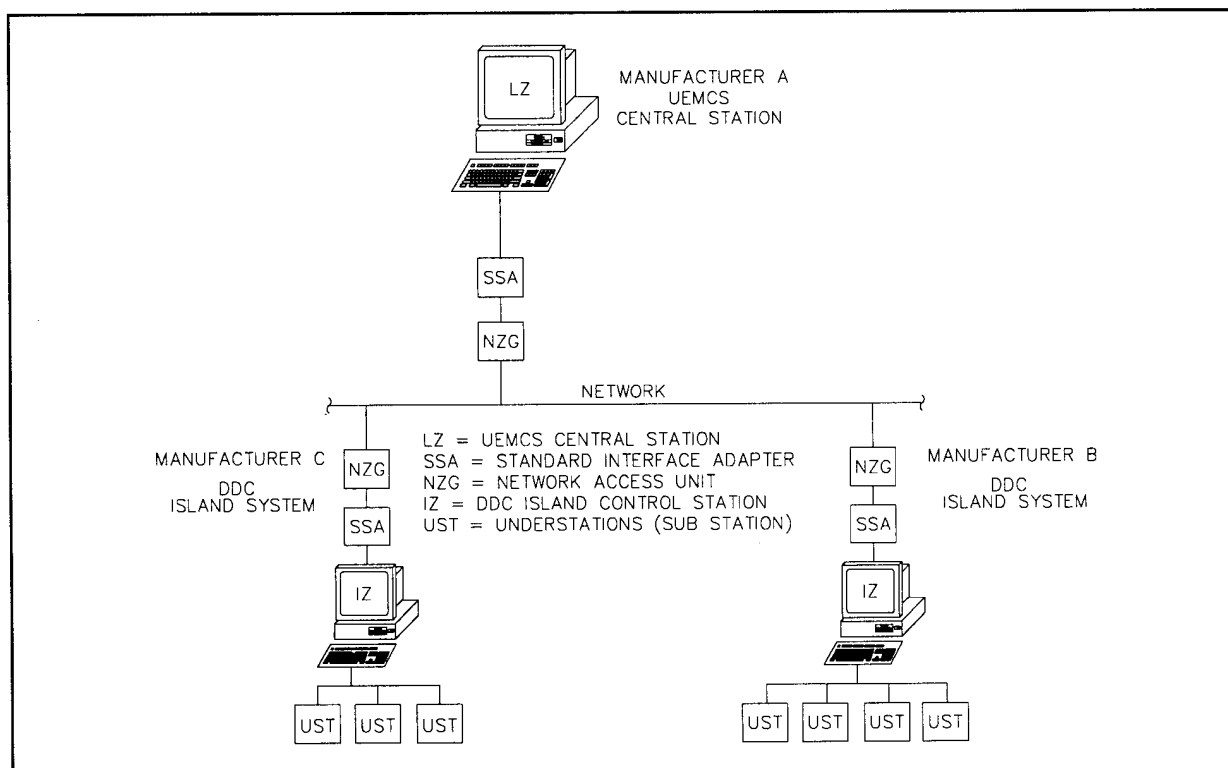


Figure 6. Standard UEMCS/FND system.

The LZ and IZs interface to the network via the Standard Interface Adapter (abbreviated SSA, for *Standard Schnittstellen-Adapter*). An SSA is an X.21/X.25 plug-in card located in the LZ and each IZ control station. The SSAs interface to the communication network through the *Netzzugangsgeraete*, or NZG. The NZG transmits FND data through the network.

While communications between the IZ and that island's USTs remain proprietary to the DDC manufacturer, UEMCS central station access to the UST field devices is accomplished through the DDC island control station. This indirect access allows the UEMCS central station interaction with the controlled processes, including overall system supervision, coordination, and control of the DDC islands control stations. This interface is achieved by requests or commands, which are generated at the UEMCS LZ and received by the DDC IZ. The IZ translates the FND protocol to its proprietary protocol and commands the field equipment to perform the functions requested by the UEMCS central station. The DDC IZ communicates with the UEMCS-LZ by transmitting unsolicited messages, such as alarm conditions, and providing operating data on request from the UEMCS-LZ.

An FND database is located at the LZ. The FND specification defines a standard format for the database. Every data point in each island control station is included in the database. Data points from each vendor must be defined in the same format within the FND database. There are six types of data points defined by the FND standard and one undefined, or "virtual point," that are used to establish and maintain the FND data base:

1. *Indication point*—a basic digital point that indicates an On/Off or logical condition.
2. *Switching point*—similar to the indication point with the added feature of status feedback.
3. *Measuring point*—reads analog variables such as temperature, valve position, or measurements based on calculations such as humidity.
4. *Positioning point*—used to control analog outputs to command a device such as a valve to a position.
5. *Counting point*—monitors variables with continuously increasing values such as flow or energy usage.
6. *Collective address point*—a collection of data grouped together for easy transfer; for example, this point type could be used to transfer IZ system data to the LZ,

updating the IZ graphics and could include analog measurements and digital status of positioning devices.

7. *Transfer point*—undefined. This point is used to transfer data between the LZ and LZ in a format agreed upon between parties.

4 Karlsruhe UEMCS/FND System Demonstration Project

Project Development

A team of Army experts, including representatives from HQ USAREUR, HQ USACE, CEHND, and USACERL selected the Karlsruhe Military Community (Milcom) in the 21st TAACOM in Germany as the UEMCS/FND demonstration site. The Karlsruhe MILCOM has since been restructured as the Karlsruhe Area Support Team under command of the 26th Area Support Group (Heidelberg). A UEMCS implementation plan was developed by The Kling-Lindquist Partnership (TKLP) for the Karlsruhe Military Community. The plan identified approximately 400 buildings as candidates for inclusion in the UEMCS.

The Karlsruhe Directorate of Public Works (DPW) selected the Smiley Barracks complex as the specific site for the UEMCS/FND demonstration. The Smiley Barracks complex consists of approximately 26 buildings and is served by a central heat distribution system. The Karlsruhe DEH purchases the primary hot water supply (district heat) for the Smiley Barracks complex from Stadtwerke Karlsruhe through a 10-year district heat contract. The present contract requires sizable fixed payments based on demand levels established by Stadtwerke Karlsruhe.

The design of the UEMCS/FND demonstration system for the Smiley Barracks complex was developed by TKLP and included a UEMCS that used three different manufacturers' hardware and software and the FND communication protocol.

Contract DAJA37-89-C-0316 was awarded by the Army's Frankfurt Contracting Office on 29 September 1989 to Otis Flohr GmbH to procure and install the demonstration UEMCS/FND system. The system consisted of an Otis Flohr GmbH UEMCS central station located in the Karlsruhe DEH office, a Haustechnik Engineering (HTE) DDC as a detached or simulated DDC island system, and a Johnson Controls DDC island system located within Smiley Barracks. The UEMCS central station and island control stations were interfaced over a Datex P-10 phone line network via NZG (modems) using standard X.21/X.25 communications cards as Standard Signal Adapters (SSA). Figure 7 shows the system block diagram.

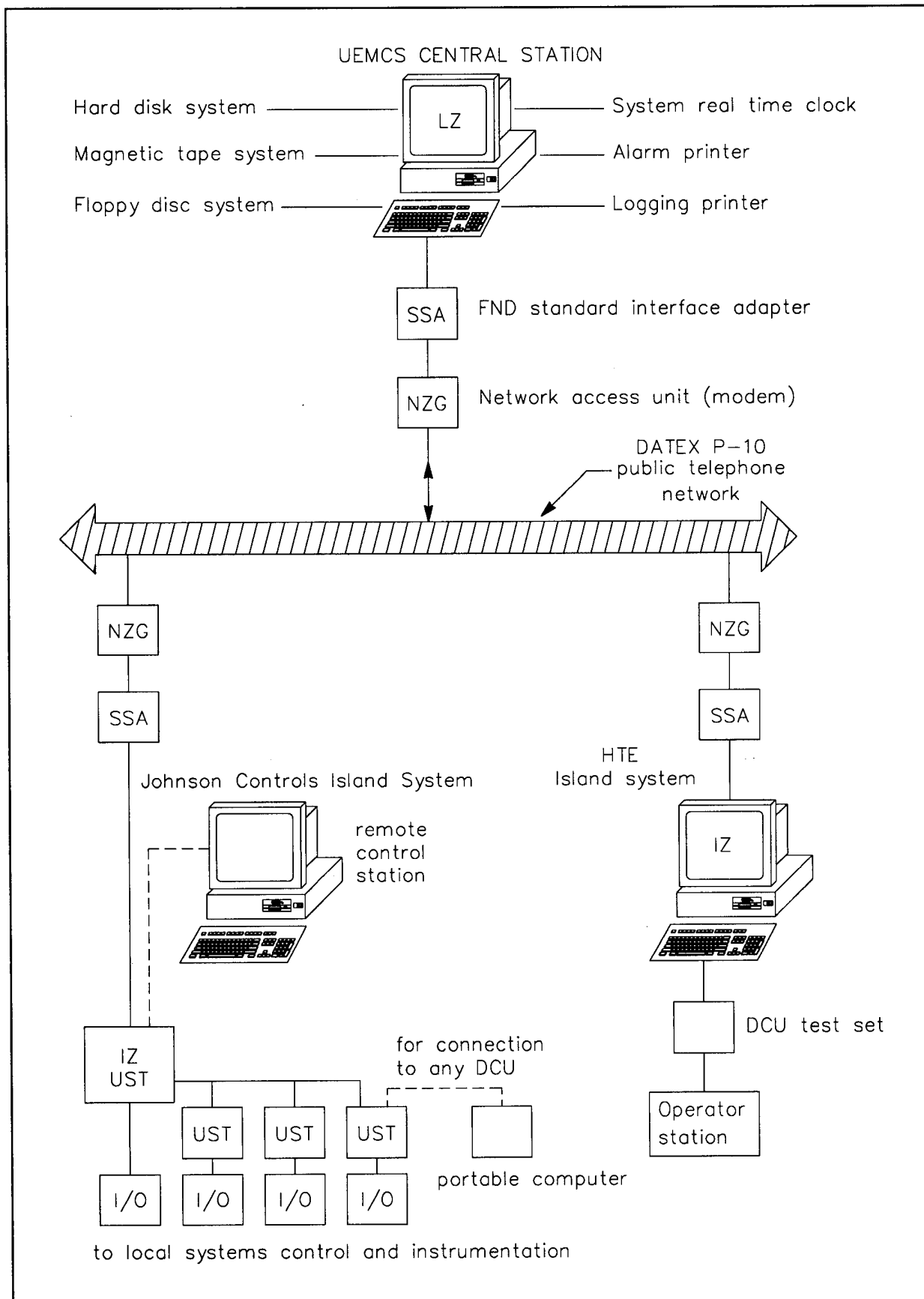


Figure 7. The Karlsruhe UEMCS/FND block diagram.

UEMCS Central Station

The UEMCS central station consists of a 386 CPU, based on a 32-bit processor with 4MB main memory (expandable to 64 MB) and 40 MB of disk memory (expandable to 2GB). This system with 4MB of main memory can easily handle 16,000 data points. By expanding the main memory to 8MB, this central station could accommodate up to 50,000 data points. The central station software provides the following functions:

1. Central Monitoring Functions

- *Alarms for protection against catastrophic failure*—early notification of high or low temperatures, and/or high pressure in the secondary hot water supply line, to prevent or minimize loss of heat to buildings and equipment damage.
- *Monitoring of primary hot water supply temperatures*—ensuring that Stadtwerke Karlsruhe is supplying hot water within the temperature range required under the district heat supply contract.
- *Monitoring and historical logging of district heat demand*—contract demand for billing purposes is established on calculations prepared by Stadtwerke Karlsruhe.

2. Central Reporting Functions

- *Status Reports*—of current condition of any equipment or data point in the system.
- *Correlated Alarm Reports*—including alarm parameters and detailed diagnostics of the data environment when an alarm condition occurs.
- *Profile Reports*—for power consumption, power demand, temperature, and equipment or subsystem profiles (value versus time).
- *Utility Utilization Reports*—including electric, water, chlorination, district heat, POL separators, including times and date.
- *Alarm Reports*—of all outstanding unacknowledged alarms by building or unit including time of occurrence.
- *Run-Time Reports*—totalizing run time of individual pieces of equipment.
- *Optimum Start-Stop Reports*—listing all systems or buildings that failed to meet occupancy requirements within 20 minutes of scheduled occupancy time, or reaching occupancy requirements 20 minutes before scheduled occupancy.
- *Out-of-Service Reports*—listing out-of-service devices.
- *Static Data Base Reports*—listing the entire static data base or selectable building, unit, or point of the values of fixed parameters or constraints.
- *Data Transmission Media (DTM) Reports*—listing all DTM circuits from the central station, control stations, and USTs including total transmissions

attempted, consecutive number of retries, total number of retries, and DTM circuit status (enabled/disabled).

3. Central Control Functions

- *Start/Enable*—to manually start equipment or enable a component or data point.
- *Stop/Disable*—to manually stop equipment or disable a component or data point.
- *Auto/Override*—to override or return a point to automatic operation.
- *Confirm Action*—to allow the operator to confirm that a desired command is correctly entered and is to be executed.
- *Cancel Action*—to allow the operator to interrupt or cancel incorrectly entered commands.
- *Print Report*—to allow the operator to initiate printing of reports.

Island System

The island system consists of a Johnson Controls SDC-8001 DDC system installed on the district heat distribution system located in Smiley Barracks. USTs were located in buildings 9258, 9268, 9270, and 9277 to monitor and control the district heat substations. The SSA and NZG were installed in the UST located in building 9277, which served as the island control station. Communication of all data points within the island system are transmitted to the central station through this UST.

A portable computer was included with the DDC island control system to allow the operator mechanic to connect directly to a UST while servicing the system. All points on the island system can be accessed through the portable computer from any UST within the island. In addition to the portable computer, a PC was located adjacent to the UST in building 9277. This provided additional access to the island system during system verification.

The island system USTs perform the following control functions:

- *Modulation of primary control valve*—to maintain secondary heating hot water supply temperature setpoint.
- *Zone mixing valves control*—for maintaining individual building heating supply water temperature.
- *Night setback of the heating supply water temperature*—to reduce energy consumption during unoccupied periods.

- *Setpoint reset of the supply water temperature based on outdoor air (OA) temperature*—to reduce secondary hot water supply temperatures when OA temperature increases, thereby reducing energy consumption as building loads decrease.
- *Circulating pumps control*—once a pump is selected as the primary, the control either lets it run continuously unless that pump fails, in which case it alarms the central station to automatically start the standby pump, or once a week, the control alternates the pumps for a 24-hour period.
- *On/Off control of domestic hot water loading pump*—based on the setpoint temperature of domestic hot water in holding tanks.
- *Freeze protection*—to prevent freezing of hot water pipes.

Detached Island System

The detached DDC-island supplied by Haustechnik Engineering (HTE) is their Star/2 system. This system simulates field I/O to a HTE UST. This detached island, while not actually performing control of any real devices, provided a means for the project researchers to readily exercise the capability of FND for a second vendor's island system. The basic UEMCS functions included in the detached island were: commands, responses, unsolicited messages, and acknowledgements. In addition, the speed and accuracy of response of the UEMCS central station could be tested for a variety of functions, including:

- *Supervision of contacts*—where a software program resident in the detached island control station generated pulsed signals to simulate a pulse accumulator input signal such as that from a flowmeter. The pulses could be generated in intervals as short as 0.1 seconds.
- *Counting on/off events*—with a limit alarm for the number of status changes.
- *Counting operating hours*—with run limit and maintenance alarms. If a run limit is exceeded for a piece of equipment, the program prevents restarting that point until a programmed disable time has elapsed.
- *State of change*—with alarm including the time of the last change.
- *Motor control (on/off)*.

System Testing

Factory (FAT), Performance Verification (PVT) and Endurance Tests were conducted according to U.S. Army Corp of Engineer Specifications during installation of the equipment to ensure that the UEMCS hardware and software met the physical and

functional requirements of the contract. The tests exercised each manufacturer's FND transmission media, including a UST with one of each I/O type function.

Before scheduling the FAT, PVT, and Endurance tests, the contractor provided the Government with test plans and procedures. The following documentation necessary for conducting the tests was submitted:

- Installed UEMCS block diagram
- UEMCS hardware description
- UEMCS software description
- Operators commands
- I/O summary tables with failure modes for test points
- Required password for each operator access level
- Description of each digital and analog I/O to be tested
- Surge and over-voltage protection circuit diagrams.

For each application program shown on the I/O summary table, the contractor provided:

- Inputs values and status required for each application program
- Default values for the inputs for the application programs to be tested
- Failure modes for each I/O function to be tested.

The contractor was required to submit a list of test equipment, including calibrations traceable and verified against a laboratory standard. The accuracy of the test equipment was required to be at least twice the maximum accuracy required for the test. The required test equipment included:

- Surge generator
- Oscilloscope
- AC signal generator
- DC signal source
- Portable diagnostic programming device
- Equipment that generates at least 10 dry contact closures per second and indicates the number of pulses transmitted
- Stop watch with 0.1 second intervals
- White noise generator or communication error generator.

The FAT and PVT consisted of 58 separate tests conducted to verify that all contract requirements were met, including:

- System accuracy, resolution, and speed from analog inputs to the LZ CRT display were within specified limits.
- Commands executed from the LZ were executed by the USTs, verifying that the system accurately displays change of status at the designated UST output point.
- Alarms in the island systems were automatically transmitted to the LZ and acknowledgment from the operator was recognized.
- Error detection and retransmission between IZs and the LZ.
- Power failure tests to ensure that the LZ and peripherals maintained memory and registers, automatically returning to full operation without human intervention within 5 minutes after power was restored.
- Tests that proved that all contractor-supplied communications equipment could withstand 400 VAC RMS surges as defined in the contract.

The factory test was conducted at the Framersheim office of Otis Flohr GmbH and witnessed by U.S. Army representatives. This test was successfully completed on 13 February 1991. Installation of system equipment was delayed following the factory test to avoid interruption of building heating during the spring of 1991. Installation of the UEMCS central station, Smiley Barracks DDC-island, and the detached island systems was completed in October 1991.

During routine site-testing, the Otis central station encountered problems related to time-synchronization. The Army's UEMCS specifications require that the UEMCS central station update the time clock on all DDC island stations, ensuring that all systems are properly synchronized. The demonstration system was not performing this function. The contractor resolved this problem by revising the system software to allow the LZ to use an FND transfer point to periodically transmit its clock time to each IZ. Each IZ would then refresh its current time based on the new data.

In March 1992 an unsatisfactory Performance Verification Test was conducted. The Johnson Control island system was producing incorrect values from various sensors, system communication response time was inadequate, and other communication errors were detected. A list of specific deficiencies was provided to the contractor. After the PVT, the entire Johnson Controls DDC-island system failed. The contractor, with considerable assistance from the Johnson Controls Stuttgart office, eventually resolved the problems, which were associated with the grounding of communication lines between DDC USTs and the sensor transmitter installations. A second PVT was conducted in July 1993, which proved to be satisfactory.

With successful completion of the PVT, Endurance Testing commenced. The Endurance Test is conducted to ensure overall long-term system reliability. During the first phase of this test, the contractor was required to allow the system to operate without human interaction. If a failure occurred during this phase, the contractor was required to provide a thorough description of the failure including a plan for correcting the deficiency. The correction would then be implemented and the first phase started over.

An interruption in communications occurred during the Endurance Test between the Smiley Barracks IZ and the LZ. The interruption was attributed to a power surge protection device that tripped during a lightning storm. A check of the IZ and LZ surge protectors found them to be working. The device that failed had been part of the Dtex P-10 public phone system and was replaced by the Bundestpost (the German telephone company).

An endurance test systems check in June 1994 uncovered that the software program for totalization of BTU hours of district heat consumed by Smiley Barracks was not performing correctly. This program uses flow rates and temperatures of district hot water entering from and returning to Stadtwerke Karlsruhe hot water distribution system. The problem was located and corrected. All other system operations functioned as specified by the project specifications during the endurance test.

Independent tests conducted by the research team on the Karlsruhe demonstration UEMCS/FND system in March 1994 verified that FND communications protocol supported all UEMCS basic functions including:

- Commands from the LZ to the IZ
- Responses from the IZ to the LZ
- Unsolicited messages from the IZ to the LZ (i.e., alarms)
- Acknowledgements by the LZ for each unsolicited message.

5 Other FND Projects

The German government has implemented numerous projects using FND technology. The initial demonstration was conducted at the University of Ulm. A Johnson Controls LZ was interfaced with Landis and Gyr and Siemens IZs. The IZ equipment monitored and controlled HVAC system located throughout the campus. Following this successful demonstration, the German government implemented FND systems in various locations throughout Germany, including:

- Berlin: LZ Honeywell, IZ Landis & Gyr
- Bonn: LZ Honeywell, IZ Staefa Control
- Braunschweig: LZ Landis & Gyr, IZ Kieback & Peter
- Hannover: LZ Johnson Controls, IZ Landis & Gyr
- Uni Karlsruhe: LZ Honeywell, IZ Kieback & Peter
- Munich: LZ Borer, IZ Kieback & Peter, IZ Sauter-Cumulus
- Stuttgart: LZ Johnson Controls, IZ Kieback & Peter
- Uni Ulm: LZ Johnson Controls, IZ Landis & Gyr, IZ Siemens.

In March 1994, U.S. Army Corps of Engineers representatives surveyed FND systems located in various German facilities. Site visits were made to inspect the FND-based systems at the University of Ulm, the University of Karlsruhe, and a Munich hospital. These systems were all UEMCS-like systems to monitor and control building mechanical and electrical subsystems including HVAC and lighting.

The use of FND technology in Germany is widespread and has gained industry support there. Vendors currently providing FND compatible systems include:

- Otis Flohr GmbH
- Haustechnik Engineering (HTE)
- Johnson Controls, International
- Landis and Gyr
- Siemens
- Honeywell
- Kieback and Peter
- Sauter-Cumulus
- Borer.

The German government application of FND is somewhat different from the U.S. Army UEMCS/FND application. In the typical German system, the central station operator monitors systems status, but only acknowledges alarms. If service is required, a service representative for the alarming island system responds to resolve the problem or service the system. The operator does generate energy consumption reports that are received by a central energy management office. The central energy management office receives reports from facilities such as hospitals, university campuses, and government buildings via FND transmitted over phone lines. The central energy office then compiles the collected data and observes trends. This data is used to establish more efficient methods of managing energy in large government facilities.

6 Conclusions and Recommendations

This study successfully demonstrated the use of the FND communications protocol in the U.S. Army's Karlsruhe, Germany military community. This study concludes that the FND-based UEMCS does support the required functions defined in CEGS 13952. In light of the results of this demonstration project and the successfully demonstrated FND-based systems that have been installed in German government facilities, it is recommended that the U.S. Army should begin to use FND to interface DDC systems to UEMCSs in USAREUR facilities. The FND offers the following technical and economic advantages when applied in a UEMCS:

- FND is a DIN standard communications protocol that has broad support by European manufacturers of building automation systems.
- FND provides the technology to integrate different manufacturers DDC systems into a base-wide energy management system with a single central station.
- FND can reduce manpower requirements by eliminating the multi-station, multi-operator control room environment.
- FND allows for free-and-open competition of FND-compatible UEMCS system expansion or replacement.

It is also recommended that:

1. FND be included as standard requirement for USAREUR UEMCS projects.
2. U.S. Army Corps of Engineers Guide Specification (CEGS) 13952, "Direct Control Utility and Energy Management and Control System," be revised to include FND requirements.

References

Corps of Engineers Guide Specification (CEGS) 15950, *Heating, Ventilation, and Air-Conditioning (HVAC) Control Systems* (Huntsville Division, U.S. Army Corps of Engineers, Huntsville, AL, July 1990).

EMC Ingenieure GmbH, *Translation of FND Parts 1, 2 and 3* (Eschborn, Germany, October 1988).

International Telephone and Telegraph Consultative Committee (CCITT), *Eight Plenary Assembly (Red Book) Recommendations*, CCITT X.21, "Series V, 'Data Communications Over the Telephone: Network Recommendations'"; CCITT X.25, "Series X, 'Data Communications Networks: Interfaces Recommendations'" (undated).

Jordan, L. and B. Churchill, *Communications and Networking for the IBM PC & Compatible, Revised and Expanded* (Brady Books, 1987).

Corps of Engineers Guide Specifications 13952, *OCONUS Utility and Energy Monitoring and Control System for USAAREUR Applications* (September 1990).

Implementation Plan For Utility and Energy Monitoring and Control System for 21st Support Command USMCA Karlsruhe (Prepared for Headquarters, U.S. Army, Europe and Seventh Army, by The Kling-Lindquist Partnership, Philadelphia, PA, December 1988).

Appendix A: Corps of Engineers Guide Specifications (CEGS) 13952, "OCONUS Direct Control Utility and Energy Monitoring and Control System"

Contents

1.	APPLICABLE PUBLICATIONS	1
2.	SYSTEM DESCRIPTION	2
3.	DELIVERY OF TECHNICAL DATA AND COMPUTER SOFTWARE	6
4.	TESTING	13
5.	TRAINING	19
6.	DATA TRANSMISSION MEDIA	22
7.	MATERIALS AND EQUIPMENT	22
8.	INSTRUMENTATION AND CONTROLS	22
9.	FIELD HARDWARE	31
10.	RCU SOFTWARE	35
11.	ISLAND FND STANDARD INTERFACE ADAPTER	51
12.	ISLAND STATION HARDWARE	52
13.	ISLAND STATION SOFTWARE	54
14.	CENTRAL STATION HARDWARE	64
15.	CENTRAL STATION SOFTWARE	67
16.	CENTRAL STATION, ISLAND STATION, AND RCU DATA COMMUNICATION REQUIREMENTS	80
17.	WIRE AND CABLE:	81
18.	GENERAL	82
19.	EXISTING CONTROLS	82
20.	EXISTING UEMCS	86
21.	INSTALLATION EQUIPMENT	87
22.	INSTALLATION SOFTWARE	90
23.	MAINTENANCE AND SERVICE	91
	GENERAL NOTES	93
	TECHNICAL NOTES	94

OCEGS-13952

AUGUST 1990

OCNUS UTILITY AND ENERGY MONITORING AND CONTROL SYSTEM (UEMCS)
FOR USARUER APPLICATIONS

PART 1 - GENERAL

1. APPLICABLE PUBLICATIONS: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1 Deutsches Arbeitskreis Maschinen - und Elektrotechnik staatlicher und Kommunalen Verwaltungen (AMEV) Specifications:

FND Specifications Firm Neutral Data Transmission System
Version 1.0

1.2 International Telephone and Telegraph Consultative Committee (CCITT), Eighth Plenary Assembly (Red Book) Recommendations:

Series V	Data Communications over the Telephone
Recommendations	Network

Series X Data Communication Networks: Interfaces
Recommendations

1.3 Deutsches Institute Fur Normung (DIN) Standards:

DIN 19208-19213	Methods for Measurement of Fluid Flow
DIN 19227	Graphical Symbols and Identifying Letters for Process Measurement and Control Functions
DIN 40050	Degrees of Protection Provided by Enclosures Protection of Electrical Equipment Against Contact, Foreign Bodies and Water
DIN 40700-40722	Graphical Symbols for Electrical and Electronic Systems and Equipment
DIN 43760	Electronic Temperature Sensors
DIN 66003	National German Code For Information Interchange

1.4 International Standards Organization (ISO) Standard:

ISO-IA5 International Alphabet (IA) No. 5
(ISO-7-BIT-CODE)

OCEGS-13952

AUGUST 1990

1.5 Verband Deutscher Elektrotechniker (VDE) Guidelines:

VDE 0100 Part Erection of Power Installations With Rated
100 to 750 Voltages Up to 1000 V

VDE 0100 Part 443 Protection Against Surge Voltages In Case of
Atmospheric Influences

VDE 0100 Part 540 Earthing Arrangements, Protective Conductors,
Equipotential Bonding Conductors

VDE 0106 Protection Against Electric Shock

VDE 0185 Part 1 and 2 Lightning Protection System

VDE 0414 Part 1 to 5 Instrument Transformers

VDE 0418 Part 1 to 12 Electricity Meters

VDE 0800 Part 2 Earthing and Equipotential Bonding

VDE 0845 Protection of Telecommunications Installations from
Overvoltages

1.6 Verein Deutscher Ingenieure (VDI) Guideline:

VDI 3814 Central Circuitry for Operational Equipment in
Buildings (ZLT-G)

2. SYSTEM DESCRIPTION:

2.1 General: The Contractor shall configure the Utility and Energy Monitoring and Control System (UEMCS) as a distributed processing network as described and shown. The system shall provide operator interaction and dynamic process manipulation, including overall system supervision, coordination, and control. Sensed data shall be obtained by the Remote Control Units (RCU) using instruments and controls interfaced to utility systems and other systems as specified and shown. RCUs shall control and monitor all functions as specified and shown. The Central Station shall communicate with Island Stations and RCUs using a Firm Neutral Data (FND) Communications system and the data transmission media (DTM) shown and specified. Island Stations shall communicate with all RCUs within their geographical area or functional group using the DTM shown and specified. Every connected analog output (AO), analog input (AI), digital output (DO), digital input (DI), pulse

OCEGS-13952

AUGUST 1990

accumulator input and logic (virtual) point represents a "point" where referred to in this specification.

2.2 System FND Communication Requirements: The system shall utilize FND communications in accordance with the AMEV FND Specifications, and shall be provided for all points, functions, parameters, and constraints identified by VDI 3814 and required by this specification. The system shall be certified to conform to the requirements of the AMEV FND specification.

2.3 System Overall Reliability: The system shall be configured and installed to yield a mean time between failure (MTBF) of at least 1000 hours, and shall be calculated based on the configuration specified in the paragraph entitled DELIVERY OF TECHNICAL DATA AND COMPUTER SOFTWARE, for overall system reliability calculations.

(C)

2.4 System Accuracy and Display: The system shall maintain the specified end-to-end accuracy for 1 year from sensor to Island Station display and from sensor to Central Station display for the applications specified and shall display values as specified.

2.4.1 Space temperature with a range of 10 to 30 degrees C plus or minus 0.5 degrees C for conditioned space (display and print to nearest 0.1 degrees C); zero to 55 degrees C plus or minus 0.5 degrees C for unconditioned space (display and print to nearest 0.1 degrees C).

2.4.2 Duct temperature with a range of 5 to 60 degrees C plus or minus 0.5 degrees C (display and print to nearest 0.1 degrees C).

2.4.3 Outside air (OA) temperature with a range of minus 35 to plus 55 degrees C plus or minus 1.0 degrees C; with a subrange of zero to plus 40 degrees C plus or minus 0.5 degrees C (display and print to nearest 0.1 degrees C).

2.4.4 Water temperature with a range of zero to 40 degrees C plus or minus 0.5 degrees C (display and print to nearest 0.1 degrees C); the range of 40 to 120 degrees C plus or minus 1.0 degree C (display and print to nearest 0.1 degrees C); and water temperatures for the purpose of performing kWh calculations using differential temperatures to plus or minus 0.2 degrees C using matched sensors (display and print to nearest 0.1 degrees C).

2.4.5 High temperature with a range of 95 to 250 degrees C plus or minus 1.0 degree C (display and print to nearest 1.0 degree C).

OCEGS-13952

AUGUST 1990

2.4.6 Relative humidity with a range of 20 to 80 percent plus or minus 6.0 percent of range (display and print to nearest 1.0 percent).

2.4.7 Pressure with a range for the specific application plus or minus 2.0 percent of range (display and print to nearest 0.1 bar).

2.4.8 Flow with a range for the specific application plus or minus 3.0 percent of range (display and print to nearest unit such as liters per minute (LPM)).

2.4.9 Level with a range for the specific application plus or minus 1.0% of range (display and print to be nearest 1.0 liters).

2.4.10 Electrical power measurements with a range for the specific application plus or minus 1.0 percent of reading (display and print to nearest kWh or kW).

2.4.11 Electrical measurements with a range for the specific application plus or minus 1.0% of reading (display and print to nearest 0.1 for volts and amps, and to the nearest 0.01 for VAR and PF).

2.4.12 An analog value input to the system's equipment via an AI with a maximum error of 0.50 percent of range, not including the sensor or transmitter error. This accuracy is required over the specified environmental conditions.

2.5 Symbols, Definitions, and Abbreviations: All symbols, definitions, and engineering unit abbreviations utilized in information displays and printouts shall conform to DIN 19227 and DIN 40700 through 40722, where applicable.

(D)

2.6 Environmental Conditions:

2.6.1 The RCU, I/O functions, Operator Interface Panels, Data Terminal Cabinets (DTC) and all other field equipment shall be rated for continuous operation under ambient environmental conditions of 2 to 45 degrees C dry bulb and 15 to 90 percent relative humidity, non-condensing. Instrumentation and control elements shall be rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location.

2.6.2 Central Station and Island Station equipment shall, unless designated otherwise, be rated for continuous operation under ambient

OCEGS-13952

AUGUST 1990

environmental conditions of 16 to 28 degrees C and a relative humidity of 20 to 80 percent, noncondensing.

2.7 Power Line Surge Protection: All equipment connected to ac circuits shall be protected from power line surges. Equipment protection shall meet the requirements of VDE 0100, VDE 0185, VDE 0800, and VDE 0845. Fuses shall not be used for surge protection.

2.8 Sensor and Control Wiring Surge Protection: All digital and analog inputs and outputs shall be protected against surges induced on control and sensor wiring installed outdoors and as shown. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms.

a. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes. Fuses shall not be used for surge protection.

2.9 Communications Circuits Surge Protection: All communication equipment shall be protected against surges induced on its communications circuit. All cables and conductors which serve as communications circuits from Central Station to Island Station and RCUs, from Island Station to RCUs, and between RCU hardware shall have surge protection installed at each end. Protection shall be furnished at equipment and additional triple electrode gas surge protectors rated for the application on each communications circuit shall be installed within 1 meter of the building cable termination. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms:

a. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes. Fuses shall not be used for surge protection.

2.10 Modems: All modems provided by the Contractor that connect to the telephone network shall be certified by the Contractor to meet the requirements of the local telephone system.

(E)

OCEGS-13952

AUGUST 1990

2.11 Power Line Conditioners (PLC): PLCs shall be furnished for the Central Station equipment, each Island Station and each RCU. The PLCs shall provide both voltage regulation and noise rejection. The PLCs shall be of the ferroresonant design, with no moving parts and no tap switching, while electrically isolating the secondary from the power line side. The PLCs shall be sized for 125 percent of the actual connected kVA load. Characteristics of the PLC shall be as follows:

a. At 85 percent load, the output voltage shall not deviate by more than plus or minus 1 percent of nominal when the input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.

b. During load changes of zero to full load, the output voltage shall not deviate by more than plus or minus 3 percent of nominal. Full correction of load switching disturbances shall be accomplished within 5 cycles, and 95 percent correction shall be accomplished within 2 cycles of the onset of the disturbance.

c. Total harmonic distortion shall not exceed 3-1/2 percent at full load.

(F,G)

3. DELIVERY OF TECHNICAL DATA AND COMPUTER SOFTWARE: All items of computer software and technical data (including technical data which relates to computer software), which is specifically identified in this specification, will be delivered strictly in accordance with the CONTRACT CLAUSES, SPECIAL CLAUSES, and in accordance with the [Contract Data Requirements List, DD Form 1423] [], which is attached to and thereby made a part of this contract. All data delivered shall be identified by reference to the particular specification paragraph against which it is furnished.

3.1 Group I Technical Data Package:

3.1.1 System Drawings: The data package shall include the following:

- a. System block diagram.
- b. Central Station equipment installation and block diagrams.
- c. Island Station equipment installation and block diagrams.
- d. RCU/DTC installation and block diagrams.

OCEGS-13952

AUGUST 1990

- e. RCU/DTC physical layout.
- f. DTM layout and functional description.
- g. Instrumentation and controls wiring and installation drawings.
- h. Details of connections to power sources, including grounding.
- I. Details of surge protection device installation.
- j. Instrumentation and control diagrams to be posted.

3.1.2 Equipment Data: A complete data package shall be delivered for all equipment and materials, including instrumentation and controls, RCU hardware, support hardware, Island Station hardware and Central Station hardware provided under this Section.

3.1.3 System Descriptions and Analyses: The data package shall include complete system descriptions, and calculations used in sizing equipment required by these specifications. Descriptions and calculations shall show how the equipment will operate as a system to meet the performance requirements of this specification. The data package shall include the following:

- a. Central Station operation.
- b. Communication speed.
- c. FND communications description.
- d. RCU memory size.
- e. Alarm response time calculations for analog and digital alarms.
- f. Command response time calculations.
- g. Automatic start up operations.
- h. Data base update procedure and response time calculations.
- I. Island Station operation.

OCEGS-13952

AUGUST 1990

- j. RCU I/O function capacity, including specified spare capacity.
- k. System expansion capability and method of implementation.
- l. RCU operation, all modes specified.
- m. Sample copy of each report specified.
- n. Color photographs representative of typical graphics.
- o. Library of graphics symbols.
- p. Library of applications programs.
- q. Data entry forms.

3.1.4 Software Data: The data package shall consist of descriptions of the operation and capabilities of software as specified. The software data shall be organized as follows:

- a. Central Station software.
- b. Island Station software
- c. RCU software (including all specified application programs).

3.1.5 System Overall Reliability Calculations: The data package shall include manufacturer's reliability data and calculations required to show compliance with the specified reliability. The calculations shall be based on the following configuration:

- a. All Central Station equipment specified.
- b. DTM equipment associated with one DTM circuit, but excluding the circuit itself.
- c. An Island Station as specified.
- d. A single RCU with total I/O functions as specified in paragraph RCU HARDWARE for the RCU test set.
- e. FND standard interface adapters associated with the Central Station and RCU hardware.

OCEGS-13952

AUGUST 1990

f. Instrumentation and controls shall not be included in the calculations.

3.1.6 Certifications: All certifications shall be delivered as specified.

3.2 Group II Technical Data Package: The Group II Technical Data Package shall include the Existing Controls Report, Existing UEMCS Report, and associated documentation as specified.

3.3 Group III Technical Data Package: The Group III Technical Data Package shall consist of Factory Testing Data. Test Procedures prepared as specified for the Factory Test shall be delivered to the Government for approval. The procedures shall explain in detail, step-by-step, actions and expected results to demonstrate compliance with the requirements of this specification, and the methods for simulating the necessary conditions of operation to demonstrate performance of the system. The Factory Test Procedures shall demonstrate the capability of the system to monitor and control equipment and to accomplish control and monitoring shown in the input-output (I/O) summary tables using the specified Factory Test Setup. Factory Test Procedures shall be delivered to the Government for approval. After receipt by the Contractor of written approval of the Factory Test Procedures, the Contractor may schedule the Factory Test. Factory Test Procedures shall contain the following information, as a minimum, for each test:

- a. Test identification number.
- b. Test title.
- c. Objective.
- d. Project specification section and paragraph number.
- e. Initial conditions (if applicable).
- f. Test equipment (if required).
- g. Sequence of events.
- h. Expected results.

3.4 Group IV Technical Data Package:

3.4.1 Performance Verification Testing and Endurance Testing Data: Test Procedures prepared as specified for the Performance

OCEGS-13952

AUGUST 1990

Verification Test and Endurance Test shall be delivered to the Government for approval. The Test Procedures shall explain in detail, step-by-step actions and expected results to demonstrate compliance with the requirements of this specification. Performance Verification Test Procedures shall be delivered to the Government for approval. Written approval by the Government of the Performance Verification Test Procedures shall be one of the prerequisites for commencing the Performance Verification Test as specified. Performance Verification Test Procedures and Endurance Test Procedures shall contain the following information, as a minimum, for each test:

- a. Test identification number.
- b. Test title.
- c. Objective.
- d. Project specification section and paragraph number.
- e. Initial conditions (if applicable).
- f. Test equipment (if required).
- g. Sequence of events.
- h. Expected results.

3.4.2 Operation and Maintenance Manuals: A draft copy of the operation and maintenance manuals, as specified for the Group V Technical Data Package, shall be delivered to the Government prior to beginning the Performance Verification Test for use during site testing.
(H)

3.4.3 Training Documentation: Lesson plans and training manuals for the specified training phases including type of training to be provided, with a list of reference material shall be delivered in both English and [German] [] language for approval.

3.4.4 Data Entry Forms: The Contractor shall deliver the completed data entry forms utilizing all data from the contract documents, Contractor's field surveys, and all other pertinent information in the Contractor's possession required for complete installation of the data base. The Contractor shall identify, and request from the Government, any additional data needed to provide a complete and operational UEMCS. The completed forms shall be delivered to the Government for review and approval at least 90 days prior to the Contractor's scheduled need date.

OCEGS-13952

AUGUST 1990

(H)

3.5 Group V Technical Data Package: The Group V Technical Data Package consists of the operation and maintenance manuals. Final copies of the manuals bound in hardback, loose-leaf binders, shall be delivered to the Government within 30 days after completing the Endurance Test. The draft copy used during site testing shall be updated with any changes required prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manuals shall include the names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and of the nearest service representatives for each item of equipment and each system. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the Endurance Test shall include all modifications made during installation, checkout, and acceptance. All manuals delivered shall be in English and [German] [] language and shall include:

- a. Functional Design Manual. [2] [] copies.
- b. Hardware Manual. [2] [] copies.
- c. Software Manual. [2] [] copies.
- d. Maintenance Manual. [2] [] copies.
- e. Operator's Manual. [6] [] copies.

3.5.1 Functional Design Manual: The functional design manual shall explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and other requirements shall be included for all system operating modes.

3.5.2 Hardware Manual: A manual describing all equipment furnished, including:

- a. General description and specifications.
- b. Installation and checkout procedures.
- c. Equipment electrical schematics and layout drawings.
- d. System schematics and I/O wiring lists.
- e. Alignment and calibration procedures.

OCEGS-13952

AUGUST 1990

f. Manufacturer's repair parts list indicating sources of supply.

g. Interface definition.

3.5.3 Software Manual:

3.5.3.1 The software manual shall have a separate section for Central Station software including:

- a. Definitions of terms and functions.
- b. Procedures for system startup.
- c. Data base format and data entry requirements.
- d. FND data base format and data entry or conversion requirements.
- e. Directory of all disk files.
- f. Parameter schedules.
- g. Operator Commands.
- h. Report generator data format, output format, and content.
- I. Alarm messages and format.
- j. System access requirements.

3.5.3.2 The software manual shall have a separate section for Island Station software including:

- a. Definitions of terms and functions.
- b. Procedures for system startup.
- c. Description of the applications programs used.
- d. Data base format and data entry requirements.
- e. FND data base format and data entry or conversion requirements.

OCEGS-13952

AUGUST 1990

- f. Directory of all disk files.
- g. Parameter schedules.
- h. Operator commands.
- I. Report generator data format, output format, and content.
- j. Alarm messages and format.
- k. System access requirements.

3.5.3.3 The software manual shall have a separate section for RCU software, including:

- a. Definitions of terms and functions.
- b. Descriptions of the applications programs used.
- c. Description of required sequences using control sequence software.
- d. Data base format and data entry requirements.
- e. FND data base format and data entry or conversion requirements.
- f. Alarm messages and format.
- g. System access requirements.

3.5.4 Operator's Manual: The operator's manual shall fully explain all procedures and instructions for operation of the system, including:

- a. Computers and peripherals.
- b. System startup and shutdown procedures.
- c. Recovery and restart procedures.
- d. Commands.
- e. Graphics.

OCEGS-13952

AUGUST 1990

f. Alarm presentation.

g. Report requests.

3.5.5 Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventative maintenance, fault diagnosis, and repair or replacement of defective components.

4. TESTING:

4.1 General: The Contractor shall perform factory testing of Central Station, Island Stations and RCUs, site testing, and adjustment of the assembled UEMCS. The Contractor is responsible for providing all personnel, equipment, instrumentation, and supplies necessary to perform all testing. Written notification of any planned testing shall be given to the Government at least 14 days prior to any test, and in no case shall notice be given until after the Contractor has received written Government approval of the specific test procedures.

4.1.1 Test Procedures and Reports: The Test Procedures shall be developed from the design documentation. The procedures shall consist of detailed instructions for test setup, execution, and evaluation of test results. The Test Reports shall be used to document results of the tests. Reports shall be delivered to the Government within 7 days after completion of each test.

4.2 Factory Test:

4.2.1 General: The Contractor shall assemble and integrate the factory test setup as specified and perform tests to demonstrate that the performance of the system satisfies the requirements of this specification, including system FND communications requirements specified in the AMEV FND specification, and in accordance with the approved Factory Test Procedures. The Factory Test shall take place during regular daytime working hours on weekdays. Model numbers of equipment tested shall be identical to those to be delivered to the site. Original copies of all data produced during Factory Testing, including results of each test procedure, shall be delivered to the Government at the conclusion of testing prior to Government approval of the test. The test report shall be arranged so that all commands, responses, and data acquired are correlated to allow logical interpretation of the data.

4.2.2 Factory Test Documentation Package: The Contractor shall deliver the factory test documentation package to the Government prior

OCEGS-13952

AUGUST 1990

to or concurrent with written notification of the scheduled factory test. The factory test documentation package shall contain the approved Test Procedures and the following information:

- a. Factory Test Equipment block diagram.
- b. UEMCS hardware description.
- c. UEMCS software description.
- d. Operator's commands.
- e. I/O summary tables with failure modes for test points.
- f. Required passwords for each operator access level.
- g. Description of each type of digital and analog I/O in the test data base.
- h. List of test equipment.
- i. Surge protection circuits diagrams.
- j. Inputs required for each application program (I/O point values and status) and corresponding expected results for each set of input values.
- k. Default values for the application program inputs not implemented or provided for in the contract documents for the application programs to be tested.
- l. Failure modes for each I/O function to be tested.
- m. FND communications implementation description.

4.2.3 Factory Test Setup: The Factory Test Setup shall include the following:

- a. Central Station Computer, keyboard and monitor.
- b. Hard disk.
- c. Magnetic tape system.
- d. System Real Time Clock.

OCEGS-13952

AUGUST 1990

- e. Alarm printer.
- f. Logging printer.
- g. FND Standard Interface Adapters.
- h. Island Station as specified.
- I. Operator Interface Panels as specified.
- j. One RCU per DTM type, but not less than two RCUs.
- k. RCU Test Set.
- l. RCU Portable Tester.
- m. Sufficient I/O functions to demonstrate the I/O capability and system normal operation.
- n. Communications circuits of each type and speed specified and shown including MODEMS, RF communications controller, encoder/decoders, transceivers, repeaters and antennas.
- o. Surge protection equipment for power, communications, and I/O functions.
- p. Software required.

4.3 Site Testing:

4.3.1 General: The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing. The Government will witness all Performance Verification and Endurance Testing, and written permission must be obtained from the Government before proceeding with each phase of testing. Original copies of all data produced, including results of each test procedure, during Performance Verification and Endurance Testing shall be turned over to the Government at the conclusion of each phase of testing prior to Government approval of the test. The Performance Verification and Endurance Tests shall not be run during scheduled seasonal off-periods of base heating and cooling systems.

4.3.2 Contractor's Field Testing: The Contractor shall calibrate field equipment, adjust all control parameters and logic (virtual) points including control loop setpoints, gain constants, and integral constraints, and verify data communications including FND

OCEGS-13952

AUGUST 1990

communications system operation before the system is placed online. Ground rods installed by the Contractor shall be tested as specified in VDE 0100 and VDE 0185. The Contractor shall calibrate each instrumentation device connected to the UEMCS by making a comparison between the reading at the device and the display at the Island Station and at the Central Station, using a standard at least twice as accurate as the device to be calibrated. The Contractor shall check each control point within the UEMCS by making a comparison between the control command at the Central Station and field-controlled device. The Contractor shall verify operation of all systems in the specified failure modes upon UEMCS failure or loss of power, and verify that all systems return to UEMCS control automatically upon resumption of UEMCS operation or return of power. The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Government that the installed complete system has been calibrated, tested, and is ready to begin Performance Verification Testing. The report shall also include a copy of the approved Performance Verification Test Procedure.

4.3.3 Performance Verification Test:

4.3.3.1 General: The Contractor shall demonstrate that the completed UEMCS complies with the contract requirements. Using approved test procedures, all physical and functional requirements of the project, including system FND communications requirements, shall be demonstrated and shown. The Performance Verification Test as specified shall not be started until after receipt by the Contractor of written permission by the Government, based on the Contractor's written report including certification of successful completion of Contractor Field Testing as specified, and upon successful completion of training as specified. Upon successful completion of the Performance Verification Test, the Contractor shall deliver test reports and other documentation as specified to the Government prior to commencing the Endurance Test.

4.3.3.2 Performance Verification Test Documentation Package: The Contractor shall deliver the Performance Verification Test Documentation Package to the Government prior to or concurrent with the Contractor's request for permission to start testing. The Performance Verification Test Documentation Package shall contain the approved Test Procedures and the following information:

- a. UEMCS block diagram.
- b. UEMCS hardware description.
- c. UEMCS software description.

OCEGS-13952

AUGUST 1990

- d. Operator's commands.
- e. I/O summary tables with failure modes for test points.
- f. Use of passwords.
- g. Description of each type of digital and analog I/O in the test.
- h. List of test equipment.
- i. Surge protection circuits diagrams.
- j. Inputs required for each application program (I/O point values and status) and corresponding expected results for each set of input values.
- k. Default values for the application program inputs not implemented or provided for in the contract documents for the application programs to be tested.
- l. Failure modes for each I/O function to be tested.
- m. FND communications implementation description.

4.3.4 Endurance Test:

4.3.4.1 General: The Contractor shall use the Endurance Test as specified to demonstrate the specified overall system reliability requirement of the completed system. The Endurance Test shall be conducted in phases as specified. The Endurance Test shall not be started until the Government notifies the Contractor in writing that the Performance Verification Test is satisfactorily completed, training as specified has been completed, correction of all outstanding deficiencies have been satisfactorily completed, and that the Contractor has permission to start the Endurance Test. The Contractor shall provide an operator to man the system 8 hours per day during regular daytime working hours, including weekends and holidays, during Phase I and Phase III Endurance Testing, in addition to any Government personnel that may be made available. The Government may terminate testing at any time when the system fails to perform within the specified MTBF and as otherwise specified. Upon termination of testing by the Government or by the Contractor, the Contractor shall commence an assessment period as described for Phase II. Upon successful completion of the Endurance

OCEGS-13952

AUGUST 1990

Test, the Contractor shall deliver test reports and other documentation as specified to the Government prior to acceptance of the system.

4.3.4.2 Phase I (Testing): The test shall be conducted 24 hours per day, 7 days per week, for 15 consecutive calendar days, including holidays, and the system shall operate within the MTBF as specified. The Contractor shall make no repairs during this phase of testing unless authorized by the Government in writing. If the system experiences no failures during the Phase I test, the Contractor may proceed directly to Phase III testing after receipt by the Contractor of written permission from the Government.

4.3.4.3 Phase II (Assessment): After the conclusion of Phase I, the Contractor shall identify all failures, determine causes of all failures, repair all failures, and deliver a written report to the Government. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the Government. The meeting shall not be scheduled earlier than 5 business days after receipt of the report by the Government. As a part of this test review meeting, the Contractor shall demonstrate that all failures have been corrected by performing appropriate portions of the Performance Verification Test. Based on the Contractor's report and the test review meeting, the Government will determine the restart point, and may require that the Phase I test be totally or partially rerun. The Contractor shall not commence any required retesting until after receipt of written notification to restart by the Government. After the conclusion of any retesting which the Government may require, the Phase II assessment shall be repeated as if Phase I had just been completed. If the retest is completed without any failures, the Contractor may proceed directly to Phase III testing after receipt by the Contractor of written permission from the Government.

4.3.4.4 Phase III (Testing): The test shall be conducted 24 hours per day, 7 days per week, for 15 consecutive calendar days, including holidays, and the system shall operate within the MBTF as specified. The Contractor shall make no repairs during this phase of testing unless authorized by the Government in writing.

4.3.4.5 Phase IV (Assessment): After the conclusion of Phase III, the Contractor shall identify all failures, determine causes of all failures, repair all failures, and deliver a written report to the Government. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall

OCEGS-13952

AUGUST 1990

recommend the point at which testing should be resumed, if any deficiencies appeared during Phase III. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the Government. The meeting shall not be scheduled earlier than 5 business days after receipt of the report by the Government. As a part of this test review meeting, the Contractor shall demonstrate that all failures have been corrected by performing appropriate portions of the Performance Verification Test. Based on the Contractor's report and test review meeting, the Government may require that the Phase III test be totally or partially rerun. The Contractor shall not commence any required retesting until after receipt of written notification to retest by the Government. After the conclusion of any retesting which the Government may require, the Phase IV assessment shall be repeated as if Phase III had just been completed.

4.3.4.6 Exclusions: The Contractor will not be held responsible for failures resulting from the following:

a. An outage of the main power supply in excess of the capability of any backup power source, provided that the automatic initiation of all backup sources was accomplished and that automatic shutdown and restart of the UEMCS performed as specified.

b. Failure of a Government furnished communications circuit.

c. Failure of existing Government owned equipment, provided that the failure was not due to Contractor furnished equipment, installation, or software.

5. TRAINING:

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5.1 General: The Contractor shall conduct training courses in the [German] [] language(s) for designated personnel in the maintenance and operation of the UEMCS as specified, including all specified hardware and software. Instructors shall be bilingual, able to speak and understand both English and the [German] [] languages. The training shall be oriented to the specific system being installed under this contract. Training manuals in the [German] [] language(s) shall be delivered for each trainee with two additional copies delivered for archival at the project site. The manuals shall include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. The Contractor is responsible for

OCEGS-13952

AUGUST 1990

furnishing all audiovisual equipment and all other training materials and supplies. Where the Contractor presents portions of the course material by audiovisuals, copies of those audiovisuals shall be delivered to the Government either as a part of the printed training manuals or on the same media as that used during the training sessions. A training day is defined as 8 hours of classroom instruction, including breaks and lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. For guidance in planning the required instruction, the Contractor should assume that attendees will be tradesmen such as electricians or boiler operators. Approval of the planned training schedule shall be obtained from the Government at least 30 days prior to the training.

5.2 Operator's Training I: The first course shall be taught at the project site for a period of 2 consecutive training days at least 3 months prior to the scheduled Performance Verification Test. The first course shall be scheduled to occur after successful completion of the Factory Test. A maximum of personnel will attend this course. Upon completion of this course, each student, using appropriate documentation, should be able to perform elementary operations with guidance and describe the general hardware architecture and functionality of the system. This course shall include:

- a. General system architecture.
- b. Functional operation of the system.
- c. Operator commands.
- d. Use and implementation of application programs, control sequences, and control loops.
- e. Color graphics generation.
- f. Data base entry and modification, including data bases required for FND communications in accordance with the AMEV FND Specifications.
- g. Reports generation.
- h. Alarm reporting.
- I. Diagnostics.
- j. Use of Central Station.

OCEGS-13952

AUGUST 1990

k. Use of Island Station.

5.3 Operator's Training II: The second course shall be taught at the project site for a period of 3 consecutive training days after completion of the Contractor's Field Testing, but before commencing the Performance Verification Test. A maximum of [5] [] personnel will attend the course. No part of the training given during this course will be counted toward completion of the Performance Verification Test. The course shall include instruction on the specific hardware configuration of the installed system and specific instructions for operating the installed system. Upon completion of this course, each student should be able to start the system, operate the system, recover the system after a failure, and describe the specific hardware architecture and operation of the system.

5.4 Operator's Training III: The third course shall be taught while the Endurance Test is in progress for a total of 16 hours of instruction per student, in time blocks of 4 hours. A maximum of [5] [] personnel will attend the course. The schedule of instruction shall allow for each student to receive individual instruction for a 4-hour period in the morning (or afternoon) of the same weekday for 4 consecutive weeks. The Contractor shall schedule his activities during this period so that the specified amount of time will be available during the Endurance Test for instructing the students. The course shall consist of "hands-on" training under the constant monitoring of the instructor. The instructor shall be responsible for determining the appropriate password to be issued to the student commensurate with each student's acquired skills at the beginning of each of these individual training sessions. Upon completion of this course, the students should be fully proficient in the operation of all system operations. The Contractor shall report to the Government the skill level of each student at the end of this course.

5.5 Operator's Training IV: The fourth course shall be taught at the project site for a period of 2 training days no later than 6 months after completion of the Endurance Test. A maximum of [5] [] personnel will attend the course. The course will be structured to address specific topics that the students need to discuss and to answer questions concerning the operation of the system. Upon completion of the course, the students should be fully proficient in system operation and have no unanswered questions regarding operation of the installed Direct Control UEMCS.

5.6 Maintenance Personnel Training: The maintenance course shall be taught at the project site after completion of the Endurance Test for

OCEGS-13952

AUGUST 1990

a period of 2 training days. A maximum of [5] [] personnel will attend the course. The training shall include:

- a. Physical layout of each piece of hardware.
- b. Troubleshooting and diagnostics procedures.
- c. Repair instructions.
- d. Preventive maintenance procedures and schedules.
- e. Calibration procedures.

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6. DATA TRANSMISSION MEDIA: The Contractor shall provide DTM systems as specified in SECTION: The Contractor shall set data rates sufficient to meet the performance requirements specified.

PART 2 PRODUCTS

7. MATERIALS AND EQUIPMENT: Units of the same type of equipment shall be products of a single manufacturer. Each major component of equipment shall have the manufacturer's name and address, and the model and serial number in a conspicuous place. All materials and equipment shall be currently in production.

8. INSTRUMENTATION AND CONTROLS:

8.1 Temperature Instruments:

8.1.1 Resistance Temperature Detector (RTD): RTDs shall be 100 ohm platinum (Pt100), in accordance with DIN 43760, with a DIN Class B tolerance. The RTD shall be encapsulated in epoxy, series 300 stainless steel, anodized aluminum, or copper. Each RTD shall be furnished with an RTD transmitter as specified mounted integrally unless otherwise shown.

8.1.2 RTD Transmitter: The RTD transmitter shall be selected to match the resistance range of the platinum RTD. The transmitter shall produce a linear 4-20 mA dc output corresponding to the required temperature span. The output error shall not exceed 0.1 percent of calibrated span. The transmitter shall include offset and span adjustments.

OCEGS-13952

AUGUST 1990

8.1.3 Temperature Switches: Temperature switches shall have a repetitive accuracy of plus or minus 1 percent of the operating ranges shown. Switch actuation shall be adjustable over the operating temperature range. The switch shall have snap action contacts (one normally open, one normally closed) rated for the application.

8.1.4 Thermowells: Thermowells shall be monel, brass, or copper for use in copper water lines; wrought iron for measuring flue gases; and austenitic stainless steel for all other applications. The thermowell shall include a connection box, sized to accommodate the temperature transmitter.

8.1.5 Instrument Shelters: Instrument shelters shall be fabricated from wood and painted white. Shelters shall have louvered sides, double tops, and slotted bottoms.

8.2 Relative Humidity Instrument: Relative humidity sensors shall use thin-film capacitive type nonsaturating sensing elements capable of withstanding a saturated condition without permanently affecting calibration or sustaining damage. The sensors shall include removable protective membrane filters. Sensors shall have a range of 20 to 80 percent, with an accuracy of plus or minus 5 percent of full scale. A transmitter located at the sensor shall be provided to convert the sensor output to a linear 4-20 mA dc output corresponding to the required humidity span. The output error shall not exceed 0.1 percent of calibrated span. The transmitter shall include offset and span adjustments.

8.3 Pressure Instruments:

8.3.1 Pressure Transducer: The pressure transducer shall withstand up to 150 percent of rated pressure, with an accuracy of plus or minus 1 percent of full scale. The sensing element shall be either capsule, diaphragm, bellows, bourdon tube, or solid state as applicable for the installation. A transmitter located at the transducer shall be provided to convert the sensing element output to a linear 4-20 mA dc output corresponding to the required pressure span. The output error shall not exceed 0.1 percent of calibrated span. The transmitter shall include offset and span adjustments.

8.3.2 Pressure Switches: Pressure switches shall have a repetitive accuracy of plus or minus 5 percent of their operating range and shall withstand up to 150 percent of rated pressure. Sensors shall be diaphragm or bourdon tube. Switch actuation shall be adjustable over the operating pressure range. The switch shall have snap-action contacts (one normally open, one normally closed) rated for the

OCEGS-13952

AUGUST 1990

application. Gauge pressure switches shall have an adjustable differential setting.

8.4 Flow Instruments:

8.4.1 Orifice Plates: Orifice plates shall be made of an austenitic stainless steel sheet of 0.32 centimeter nominal thickness with an accuracy of plus or minus 1 percent of full flow. The orifice plate shall be flat within 0.0025 centimeters. The orifice surface roughness shall not exceed 0.51 micrometers. The thickness of the cylindrical face of the orifice shall not exceed one-fiftieth of the pipe inside diameter or one-eighth of the orifice diameter, whichever is smaller. The upstream edge of the orifice shall be square and sharp. Concentric orifice plates shall be used in all applications except steam flow measurement in horizontal pipelines. For steam flow measurement in horizontal pipelines, eccentric orifice plates shall be used.

8.4.2 Flow Nozzles: Flow nozzles shall be made of austenitic stainless steel with an accuracy of plus or minus 1 percent of full flow. The inlet nozzle form shall be elliptical and the nozzle throat shall be the quadrant of an ellipse. The thickness of the nozzle wall and flange shall be such that distortion of the nozzle throat from strains caused by the pipeline temperature and pressure, flange bolting, or other methods of installing the nozzle in the pipeline shall not cause the accuracy to degrade beyond the specified limit. The outside diameter of the nozzle flange or the design of the flange facing shall be such that the nozzle throat shall be centered accurately in the pipe.

8.4.3 Venturi Tubes: Venturi tubes shall be made of cast iron or cast steel and shall have an accuracy of plus or minus 1 percent of full flow. The throat section shall be lined with austenitic stainless steel. Thermal expansion characteristics of the lining shall be the same as that of the throat casting material. The surface of the throat lining shall be machined to a 1.3 micrometer finish, including the short curvature leading from the converging entrance section into the throat.

8.4.4 Annular Pitot Tubes: Annular pitot tubes shall be averaging type differential pressure sensors with four total head pressure ports and one static port made of austenitic stainless steel. Sensor shall have an accuracy of plus or minus 2 percent of full flow.

8.4.5 Turbine Meters: Turbine meters shall be austenitic stainless steel with an accuracy of plus or minus 1 percent of actual flow. Turbine flowmeters shall consist of two components, a turbine and an electronic transmitter. The turbine shall measure the flow, and the electronic transmitter shall produce a linear analog output of 4-20 mA

OCEGS-13952

AUGUST 1990

dc corresponding to the required flow span. The transmitter shall include offset and span adjustments.

8.4.6 Vortex Shedding Flowmeter: The vortex shedding flowmeter shall produce an analog 4-20 mA dc signal that is linearly proportional to the volumetric flow rate. The accuracy shall be within plus or minus 0.8 percent of the actual flow. The electronic transmitter for the vortex shedding flowmeter shall be internal or external mounting within 15 meters of the flow sensor. The flow meter body shall be made of austenitic stainless steel. The Vortex shedding flowmeter body shall not require removal from the piping in order to replace the shedding sensor.

8.4.7 Flow Switch: Flow switches shall have a repetitive accuracy of plus or minus 10 percent of actual flow setting. Switch actuation shall be adjustable over the operating flow range. The switch shall have snap-action contacts (one normally open, one normally closed) rated for the application.

8.4.8 Liquid Level Switches For Storage Tanks: Liquid level switches shall be displacement type, with a minimum of two tandem floats with each float independently activating a set of contacts (one normally open, one normally closed) at two different level settings. Each switch shall have a narrow differential band. The mounting connection shall be threaded or flanged to suit the application. All surfaces in contact with the tank contents shall be austenitic stainless steel. Switch enclosure shall be of explosion-proof design for use in a hazardous environment, and complete with a sealed watertight junction box, terminal block, and mounting plate. Each set of contacts shall be a snap-action, dry contact type with one normally open and one normally closed contact rated for the application. The switch shall be actuated by a magnetically-equipped stainless steel displacer. Repetitive accuracy shall be + 1/4 inch of actual displacer setting.

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8.4.9 Liquid Level Sensors For Storage Tanks: Liquid level sensors shall produce an analog 4-20 mA dc signal that is proportional to the level to be measured. Sensor shall be a capacitance-type, with a two-wire transmitter. The two-wires will transmit the output signal and power the transmitter. The transmitter shall have offset and span adjustments, and have an accuracy of + 0.1% of calibrated span.

8.4.10 Positive Displacement Flow Meters: The flow meter shall be a direct reading, displacement type rated for hot or cold water service as shown. A counter shall be mounted on top of the meter, and consist of a nonresettable totalizer for local reading, and a pulse

OCEGS-13952

AUGUST 1990

transmitter for remote reading. The totalizer shall have a six digit register to indicate the volume passed through the meter in cubic meters, and a sweep-hand dial to indicate down to 0.1 cubic meters. The pulse transmitter shall have a hermetically sealed reed switch which is activated by magnets fixed on gears of the counter. The meter shall have a bronze body with threaded or flanged connections as required for the application. Output accuracy shall be plus or minus 2 percent of the flow range.

8.5 Electric Power Instruments:

8.5.1 Potential Transformers: Potential transformers shall be in accordance with VDE 0414 Parts 1 to 5.

8.5.2 Current Transformers: Current transformers shall be in accordance with VDE 0414 Parts 1 to 5.

8.5.3 Watthour Meters: Watthour meters shall be in accordance with VDE 0418 Parts 1 to 12 and have pulse initiators for remote monitoring of watthour consumption. Pulse initiators shall consist of contacts (one normally open, one normally closed) with a current rating not to exceed 2 amperes and voltage not to exceed 500 V, with combinations of VA not to exceed 100 VA, and a life rating of one thousand million operations. Meter sockets shall be in accordance with VDE 0418 Parts 1 to 12.

8.5.4 Watthour Meters With Demand Register: Meters shall be in accordance with VDE 0418 Parts 1 to 12 and have pulse initiators for remote monitoring of watthour consumption and instantaneous demand. Pulse initiators shall consist of contacts (one normally open, one normally closed) with a current rating not to exceed 2 amperes and voltage not to exceed 500 V, with combinations of VA not to exceed 100 VA, and a life rating of onethousand million operations. Meter sockets shall be in accordance with VDE 0418 Parts 1 to 12.

8.5.5 Watthour Transducers: Watthour transducers shall have an accuracy of plus or minus 0.25 percent of full scale for kW and kWh outputs from full lag to full lead power factor. Input ranges for kW and kWh transducers shall be selectable without requiring the changing of current or potential transformers. The output shall be 4-20 mA dc.

8.5.6 Current Sensing Relays: Current sensing relays shall provide a normally-open contact rated at a minimum of 50 volts peak and 1/2 ampere or 25 VA, noninductive. There shall be a single hole for passage of current carrying conductors. The devices shall be sized for

OCEGS-13952

AUGUST 1990

operation at 50 percent rated current based on the connected load. Voltage isolation shall be a minimum of 600 volts.

8.5.7 Current Transducers: Current transducers shall accept an ac current input and provide a proportional 4-20 mA dc output, with an accuracy of + 0.25 percent of full scale. An integral power supply shall be provided if required for the analog output signal. The current transducer shall have a full scale input range of 0 to [5] [] amperes ac. The device shall have a means for calibration. A current transformer shall be provided as required for the application.

8.5.8 Voltage Transducers: Voltage transducers shall accept an ac voltage input and provide a proportional 4-20 mA dc output, with an accuracy of + 0.25 percent of full scale. An integral power supply shall be provided if required for the analog output signal. The voltage transducer shall have a full scale input range of 0 to [300] [] volts ac. The device shall have a means for calibration. A potential transformer shall be provided as required for the application.

8.5.9 VAR Transducer: VAR transducers shall measure the reactive volt amperes of a [single] [three] phase system, and produce a proportional 4-20 mA dc output signal. An integral power supply shall be provided if required for the analog output signal. The transducer shall have an accuracy of + 0.25 percent of full scale, and shall include offset and span adjustments. A current transformer shall be provided as required for the application.

8.5.10 PF Transducers: PF transducers shall measure the power factor on a [single] [three] phase load, and produce a proportional 4-20 mA dc output signal linear with phase angle over the range of 60 degrees lag through 60 degrees lead. An integral power supply shall be provided if required for the analog output signal. The transducer shall have an accuracy of + 0.5 percent of full scale, and shall include offset and span adjustments.

8.6 Output Devices:

8.6.1 Control Relays: Control relay contacts shall have utilization category and ratings selected for the application, with a minimum of 2 sets of contacts (2 normally open, 2 normally closed) enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage.

OCEGS-13952

AUGUST 1990

8.6.2 Time Delay Relays: Time delay relay contacts shall have utilization category and ratings selected for the application with a minimum of 2 sets of contacts (2 normally open, 2 normally closed) enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Relays shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage. Delayed contact opening or closing shall be adjustable from [1] [] to [60] [] seconds with a minimum accuracy of plus or minus 2 percent of setting.

8.6.3 Latching Relays: Latching relay contacts shall have utilization category and ratings selected for the application with a minimum of 2 sets of contacts (2 normally open, 2 normally closed) enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage.

8.6.4 Reed Relays: Reed relays shall be encapsulated in a container housed in a plastic, epoxy, or metal case. Contacts shall have utilization category and ratings selected for the application. Operating and release times shall be 1 millisecond or less. Relays shall be rated for a minimum life of 10 million operations and shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage.

8.6.5 Contactors: Contactors shall be of the single coil, electrically operated, mechanically held type. Positive locking shall be obtained without the use of hooks, latches, or semipermanent magnets. Contacts shall be double break silver to silver type protected by arcing contacts where necessary. Number of contacts, utilization category and ratings shall be selected for the application. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage.

8.6.6 Solid State Relays: Input-output isolation shall be greater than 1000 megohms with a breakdown voltage of 1500 V root mean square or greater at 50 Hz. Relays shall be rated for a minimum life of 10 million operations. The ambient temperature range shall be at least minus 28 to plus 60 degrees C. Input impedance shall not be less than 500 ohms. Relays shall have utilization category and ratings selected for the application. Operating and release times shall be 1 millisecond or less. Transients shall be limited to 150 percent of control voltage.

OCEGS-13952

AUGUST 1990

8.6.7 Electric Solenoid Operated Pneumatic (EP) Valve: EP valves shall have three port operation: common, normally open, and normally closed. EP valves shall have an outer cast aluminum body with internal parts constructed of brass, bronze, or stainless steel. EP valves shall be rated for 3.5 bars when used in control system operation at 2 bars or less, or rated at 10 bars when used in control system operation from 2 to 7 bars. EP coils shall be equipped with transient suppression to limit transients to 150 percent of rated voltage. EP valve operation shall be rated for a minimum of 104 degrees C.

8.6.8 Single Input Control Point Adjustment (CPA) Controller: Single input CPA controllers shall permit changing of control points remotely by varying the CPA port value. CPA shall be plus or minus 10 percent of primary sensor span. Controllers shall operate from electronic or pneumatic sensors as shown. Controllers shall be complete with adjustable setpoint, adjustable gain (proportional band), and shall be field selectable for direct or reverse action. Pneumatic units provided shall be constructed to withstand a maximum pressure of 2 bars. All controller inputs and outputs shall be provided with internal or external gauges or meters for calibration of input and output signals.

8.6.9 Dual Input Controller: Dual input controllers shall permit changing of control points remotely by varying the second port input value. Controllers shall operate from electronic or pneumatic sensors as shown. Controllers shall be complete with adjustable setpoint, adjustable gain (proportional band), adjustable authority, and shall be field selectable for direct or reverse action. Authority effect of secondary sensor on setpoint shall be adjustable from 33 to 100 percent of primary sensor span. Pneumatic units shall be constructed to withstand a maximum pressure of 2 bars. All controller inputs and outputs shall be provided with internal or external gauges or meters for calibration of input and output signals.

8.6.10 Electric to Pneumatic (EP) Transducers: EP transducers shall be matched to the AO signals and have a linearly proportional pneumatic output compatible with the pneumatic control loop to be interfaced. The EP transducer shall have pressure calibration adjustments and withstand pressures at least 150 percent of the maximum range. The pneumatic output shall be linearly proportional within one percent of the electric input. EP transducers shall include offset and span adjustment. EP Transducers shall be rated for minus 17 to plus 60 degrees C continuous operation. The body shall be cast aluminum with internal parts constructed of brass, bronze, or stainless steel.

8.6.11 Motorized Potentiometers: Motorized potentiometers shall be reversible brushless alnico or samarium cobalt permanent magnet dc

OCEGS-13952

AUGUST 1990

motors with rotary potentiometers coupled to the motor or gearhead output shaft. Motors shall be 2 centimeters nominal diameter or larger, with a minimum rated life of 1,000 operating hours or 200,000 revolutions. Motors shall accept signals for clock-wise rotation and for counter clockwise rotation. With no signal present, the motor shall remain stationary. Rotary potentiometers shall be wire wound or conductive plastic, single or multi-turn potentiometers with a minimum rated life of 200,000 revolutions. Potentiometers shall have a maximum resistance tolerance of plus or minus 10 percent and a maximum linearity tolerance of plus or minus one percent. Potentiometers shall be rated for a minimum of one watt at 50 degrees C. Motorized potentiometers shall be housed in enclosures with IP-44 rating and shall be suitable for operation at ambient temperatures of 2 to 50 degrees C.

8.6.12 Potentiometer-to-Current Transducers: Potentiometer-to-Current transducers shall have an accuracy of plus or minus 0.1 percent of span for 3-wire potentiometer inputs between 100 and 10,000 ohms full scale. Potentiometer-to-Current transducers shall provide continuous span adjustments between 75 and 100 percent of the input range and continuous zero offset adjustment between 0 and 10 percent of the input range. Potentiometer-to-Current transducers shall provide excitation current to the potentiometer and shall drive a 4-20 mA dc output signal, with 500 volts peak-to-peak isolation between input and output terminals. Potentiometer-to-Current transducers shall be suitable for operation at ambient temperatures of minus 25 to plus 50 degrees C.

8.7 Position Sensors:

8.7.1 End (Limit) Switch: Limit switches shall be of the enclosed or sealed type as required for the application. Contacts (one normally open, one normally closed) shall be snap-action with utilization category and ratings selected for the application.

8.7.2 Potentiometers: Potentiometers may be either rotary or linear, depending on the application of each position indicator. Position potentiometers shall have a linearity of plus or minus 5 percent and shall indicate position on a percent open basis.

8.7.3 Key-Operated Switches: Hand-off-automatic (HOA), off-automatic, and all similar-use switches shall be key-operated with all switches keyed alike. All switches shall be rated for a minimum of 600 Vac, 5A, with utilization category selected for the application and shall be mounted in an enclosure as specified.

OCEGS-13952

AUGUST 1990

8.8 Enclosures: Enclosures shall conform to the requirements of DIN 40050 for the types specified. Finish color shall be the manufacturer's standard, unless otherwise specified. Damaged surfaces shall be repaired and refinished using original type finish. Enclosures installed indoors shall be IP-23. Enclosures installed outdoors shall be IP-44. Enclosures for RCU hardware installed outdoors shall contain a thermostatically controlled space heater to maintain the enclosure above the dew point.

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8.9 Instrumentation and Control Diagrams: Framed mylar drawings in laminated plastic shall be provided. Drawings shall show complete I&C diagrams for all equipment furnished and interfaces to all existing equipment, at each respective equipment location. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system manually shall be prepared in typed form, in the English and [German] [] languages, framed as specified for the I&C diagrams and posted beside the diagrams. Proposed diagrams, instructions, and other sheets shall be submitted prior to posting. The instructions shall be posted before performance verification of the systems begins. Provide a mylar reproducible of each I&C diagram in addition to the posted copy.

(K)

8.10 Nameplates: Laminated plastic nameplates in English and [German] [] shall be provided for all equipment devices furnished. Each nameplate shall identify the function, such as "mixed air controller" or "cold deck temperature sensor." Laminated plastic shall be 0.3 centimeter thick, white with black center core. Nameplates shall be a minimum of 2.5 centimeter by 7.5 centimeter with minimum 0.6 centimeter high engraved block lettering. Nameplates for devices smaller than 2.5 centimeters by 7.5 centimeters shall be attached by a nonferrous metal chain. All other nameplates shall be attached to the device.

9. FIELD HARDWARE

9.1 RCU Hardware:

9.1.1 General: RCUs shall be microcomputer-based with a minimum word size of eight bits. Sufficient memory shall be provided to perform all specified and shown RCU functions and operations, including all spares.

9.1.2 The RCU shall include:

OCEGS-13952

AUGUST 1990

- a. Main power switch.
- b. Power on indicator.
- c. Portable tester connector.
- d. On-Off-Auto switches for each digital output.
- e. Minimum-Maximum-Auto switches, or Auto-Manual switches with manual Potentiometer, for each analog output.

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9.1.3 Communications interfaces for each DTM circuit specified in Sections: between RCUs and the Island Stations and between RCUs and the Central Station shall be provided. MODEMs suitable for each DTM specified, which will provide for transmission speeds necessary to comply with performance requirements specified shall be provided.

9.1.4 Communications interfaces shall be provided between each RCU and all associated I/O functions.

9.1.5 A sealed battery backup for the RCU RAM and real time clock function sufficient to maintain them for a minimum period of 8 hours shall be provided. Automatic charging of batteries shall be provided, or alternately, lithium batteries sized to provide a minimum of 30 days operation and a shelf life of 2 years shall be provided.

9.1.6 A single phase, 220 Vac electrical service outlet for use with test equipment shall be furnished either inside or within 2 meters of the RCU enclosure.

9.1.7 Locking type mounting cabinets, with common keying and door switch wired to an RCU input for intrusion alarm annunciation, shall be furnished.

9.2 I/O Functions:

9.2.1 I/O functions shall be defined as functionally part of the RCU as specified, but may be remotely located (where specified) from the RCU and communicate over a dedicated communication circuit. When remotely located, the I/O functions shall be subject to the same requirement as for RCU hardware.

9.2.2 Each RCU shall contain all necessary I/O functions to connect to field sensors and control devices. I/O function operation shall be fully supervised by the RCU to detect I/O function failures.

OCEGS-13952

AUGUST 1990

Each RCU shall have a minimum of 10 percent of its I/O functions as spare capacity. The type of spares shall be in the same proportion as the implemented I/O functions on the RCU, but not less than two spare points of each implemented I/O type. The RCU shall be furnished complete, with no changes or additions necessary to utilize activation of spare functions. Output relays associated with digital signals shall be considered part of the I/O function, whether physically mounted in the enclosure or separately mounted. Activation of spare points by others shall require only providing the additional field sensor or control, field wiring including connection to the system, and point definition assignment by the operator.

9.2.3 The Analog Input (AI) function (Measuring function as defined in VDI 3814) shall monitor each analog input, perform A-to-D conversion, and hold the digital value in a buffer for interrogation. The A-to-D conversion shall have a minimum resolution of 10 bits plus sign. Signal conditioning shall be provided for each analog input. All analog inputs shall be individually calibrated for zero and span, in hardware or in software. The AI shall incorporate common mode noise rejection of 50 dB from 0 to 100 Hz for differential inputs, and normal mode noise rejection of 20 dB at 50 Hz from a source impedance of 10,000 ohms. Input ranges shall be within the range of 0-20 Vdc or 4-20 mA dc.

9.2.4 The Analog Output (AO) function (Positioning function as defined in VDI 3814) shall accept digital data, perform D-to-A conversion, and output a signal within the range of 0-20 Vdc or 4-20 mA dc. D-to-A conversion shall have a minimum resolution of 8 bits plus sign. All analog outputs shall be individually calibrated for zero and span. Short circuit protection on voltage outputs and open circuit protection on current outputs shall be provided.

9.2.5 The Digital Input (DI) function (Indication function as defined in VDI 3814) shall accept on-off, open-close, or other change of state (two state data) indications. Isolation and protection against an applied steady-state voltage up to 320 Vac peak shall be provided.

9.2.6 The Digital Output (DO) function (Switching function as defined in VDI 3814) shall provide contact closures for momentary and maintained operation of output devices. Closures shall have a minimum duration of 0.1 second. DO relays shall have an initial breakdown voltage between contacts and coil of at least 500 V peak. Electromagnetic interference suppression shall be furnished on all output lines to limit transients to nondamaging levels. Protection against an applied steady-state voltage up to 320 Vac peak shall be provided. Minimum contact rating shall be one ampere at 24 Vac.

OCEGS-13952

AUGUST 1990

9.2.7 The pulse accumulator function (Counting function as defined in VDI 3814) shall have the same characteristics as the DI, except that, in addition, a buffer shall be provided to totalize pulses and allow for interrogation by the RCU. The pulse accumulator shall accept rates up to 5 pulses per second. The totalized value shall be reset to zero upon operator's command.

9.2.8 Signal conditioning for sensors shall be provided as specified.

9.2.9 Upon failure of the I/O function, including data transmission failure, connected controls shall be forced to the failure mode shown in I/O summary tables.

9.3 Data Terminal Cabinet:

9.3.1 The DTC shall serve as an interface between each RCU and associated instrumentation and controls. No instrumentation or control devices shall be located within the DTC.

9.3.2 The DTC shall be an independent metallic enclosure not physically part of the RCU or I/O functions. The DTC shall be sized to accommodate the number of I/O functions required for each RCU including installed spares, plus 25 percent expansion for each type of I/O function provided.

9.3.3 The DTC shall be divided into analog and digital groupings, each with separate sensor and control signal wiring raceways.

9.3.4 The DTC shall be provided with double sided screw type terminal strips. One side of the terminal strip shall be used for termination of field wiring from instrumentation and controls. The other side shall be used to connect the DTC to the RCU. Terminal strips shall have individual terminal identification numbers.

9.3.5 The DTC shall be a locking type mounting cabinet with common keying and door switch wired to an RCU input for intrusion alarm annunciation. DTC keying shall be identical to RCU keying.

9.4 Operator Interface Panel:

9.4.1 General: Operator Interface Panels shall be provided for use with RCUs. Operator interface panels shall be either permanently affixed to each RCU or able to be connected to each RCU as shown. Operator interface panels shall include a keyboard and LCD display for local programming and setup.

OCEGS-13952

AUGUST 1990

9.4.2 The Operator Interface Panel shall be provided with communications interfaces to each RCU in the installation or functional group as specified. The Operator Interface Panel shall:

- a. Allow for entry of RCU RAM resident information, including parameters and constraints, from the keyboard.
- b. Display any digital, analog, and pulse accumulator input.
- c. Control any digital and analog output.
- d. Provide operator interface in alphanumeric and decimal.
- e. Disable/enable each RCU.

9.5 RCU Portable Tester: A portable tester for connection to any RCU shall be provided. The tester shall include a keyboard, display, and mass storage device sufficient to perform all specified diagnostics, exercise all points, and load all RAM resident programs and information required for operation as specified. The tester shall:

- a. Run RCU diagnostics.
- b. Load all RCU RAM resident programs and information, including parameters and constraints.
- c. Display any digital, analog, and pulse accumulator input.
- d. Control any digital and analog output.
- e. Provide operator interface in alphanumerics and decimal.
- f. Display any RCU memory location.
- g. Modify any RCU RAM location.
- h. Accept RCU software and information via a CCITT V.24/V.28 port on the UEMCS computer system provided, for subsequent loading into a specific RCU.

9.6 RCU Test Set:

9.6.1 An RCU test set, consisting of a RCU and I/O simulator, shall be provided for use at the Central Station or Island Station provided, connected via a separate DTM circuit as specified. The I/O simulator shall manually generate the values or status for all I/O

OCEGS-13952

AUGUST 1990

functions specified. The I/O simulator shall receive, display, and send different types of signals. All cables, connectors, test jacks, controls, indicators, and equipment required to simulate the I/O sensors and control devices and display the operation of the RCU shall be included. Indicators and controls shall be installed in a control panel. Test jacks for all input and output signals of the I/O simulator shall be front panel mounted for use in diagnostics and evaluation. The I/O functions mix, including indicators and controls, shall be at least:

- a. 4 AI.
- b. 4 AO.
- c. 16 DI.
- d. 16 DO.
- e. 2 pulse accumulator inputs.
- f. One each of any other type utilized in the system.

10. RCU SOFTWARE

10.1 RCU Functions: The Contractor shall provide software necessary to accomplish the following functions, fully implemented and operational, within the RCU:

- a. Scanning of inputs.
- b. Control of outputs.
- c. Report alarms automatically to Island Station and Central Station.
- d. Report I/O status to Island Station and Central Station upon Island Station request and upon Central Station request.
- e. Maintain real time (time of day), updated by the Island Station or Central Station at least once per day.
- f. Accept and process transmitted data as specified in Paragraph: CENTRAL STATION, ISLAND STATION, AND RCU DATA COMMUNICATION REQUIREMENTS.
- g. Execute RCU resident applications programs.

OCEGS-13952

AUGUST 1990

- h. Averaging or filtering of all analog inputs.
- I. Constraints checks (prior to command issuance).
- j. RCU diagnostics.
- k. RCU portable tester operation as specified.

10.2 RCU Operating System: The RCU shall contain an operating system that controls and schedules RCU activities in real time. The RCU shall maintain a point data base in its RAM that includes all parameters, constraints, and the latest value or status of all points connected to that RCU. The execution of RCU applications programs shall utilize the data in this RAM resident file. The operating system shall include a real time clock function that maintains the seconds, minutes, hours, date and month, including day of the week. Each RCU real time clock shall be synchronized with the Island or Central Station at least once per day automatically to plus or minus 1 minute. The time synchronization shall be accomplished without operator intervention and without requiring system shutdown. The operating system shall allow local loading of software and data files from the portable tester.

10.3 I/O Point Data Base:

10.3.1 Each I/O point shall be defined in a data base in the RCU. The definition shall include all physical parameters and constraints associated with each point.

10.3.2 Parameter Definition: Each I/O point shall be defined and entered into the data base by the Contractor, including as applicable:

- a. Name.
- b. Device or sensor type (i.e., sensor, control relay, motors).
- c. Point identification number.
- d. Area.
- e. Military Community.
- f. RCU number and channel address.
- g. Sensor range.

OCEGS-13952

AUGUST 1990

- h. Controller range.
- I. Sensor span.
- j. Controller span.
- k. Engineering units conversion (scale factor).
- l. High reasonableness value (analog).
- m. Low reasonableness value (analog).
- n. High alarm limit (analog)
- o. High alarm limit differential (return to normal).
- p. Low alarm limit(analog)
- q. Low alarm limit differential (return to normal).
- r. Analog change differential (for reporting).
- s. High accumulator limit (pulse).
- t. Status description (digital inputs).

10.4 Alarm Processing: Each RCU shall have alarm processing software for operating range before being annunciated as a return-to-normal-state. All values shall be compared to predefined high limits and alarmed each time a value enters a limit condition. Unique high limits shall be assigned to each pulse accumulator point in the system. High limits shall be stored in the RCU data base.

10.5 Constraints:

10.5.1 Equipment Constraints Definitions: Each control point in the data base shall have RCU resident constraints defined and entered by the Contractor, including as applicable:

- a. Maximum starts (cycles) per hour.
- b. Minimum off time.
- c. Minimum on time.
- d. High limit (value in engineering units).

OCEGS-13952

AUGUST 1990

e. Low limit (value in engineering units).

10.5.2 Constraints Checks: All control devices connected to the system shall have the RCU memory resident constraints checked before each command is issued to insure that no equipment damage will result from improper operation. Each command shall be executed by the RCU only after all constraints checks have been passed. Each command point shall have unique constraints assigned. High and low "reasonableness" values or one differential "rate-of-change" value shall be assigned to each analog input. Values outside the reasonableness limits shall be rejected and an alarm message sent to the Island Station and the Central Station. Status changes and analog point values shall be reported to the Island Station upon Island Station operator request, and to the Central Station upon Central Station operator request, such as for reports, alphanumeric displays, graphic displays, and applications programs. Each individual point shall be capable of being selectively disabled by the operator from the Island Station and from the Central Station. Disabling a point shall prohibit monitoring and control of that point.

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10.6 RCU Diagnostics: Each RCU shall have self-test diagnostic routines implemented in firmware. The tests shall include routines that exercise memory. Diagnostic software shall be provided for use in the portable tester. The software shall display messages in [German] [] language to inform the tester's operator of diagnosed problems.

10.7 RCU Startup: The RCU shall have startup software that causes automatic commencement of operation without human intervention, including startup of all connected I/O functions. An RCU restart program based on detection of power failure at the RCU shall be included in the RCU software. Upon restoration of power to the RCU, the program shall restart all equipment and restore all loads to the state at time of power failure, or to the state as commanded by time programs or other overriding programs. The restart program shall include start time delays between successive commands to prevent demand surges or overload trips.

10.8 RCU Operating Mode: Each RCU shall control and monitor all functions as specified independent of communications with the Island Station and Central Station. This software shall perform RCU functions and RCU resident applications programs as specified using data obtained from I/O functions and based upon the RCU real time clock function. When communications circuits between the RCU and Island Station are operable, the RCU shall obtain real time clock up-dates transmitted from the Island Station. The RCU software shall execute commands after

OCEGS-13952

AUGUST 1990

performing constraints checks in the RCU. Status and analog values, including alarms and other data shall be transmitted to the Island Station and Central Station as specified when communications circuits are operable. Otherwise, operational data involving the latest status and value of each point, and results of calculations normally transmitted to the Island Station and Central Station, shall be stored for later transmission to the Island Station and Central Station. Twenty-four hours of data storage for these values shall be provided. The RCU shall accept software downloaded from the Island Station and FND-specified data from the Central Station. Constraints shall reside at the RCU.

10.9 RCU Failure Mode: Upon detection of low battery voltage the RCU shall perform an orderly shutdown and force all RCU outputs to a predetermined state, consistent with the failure modes defined in the I/O summary tables and the associated control device.

10.10 Analog Monitoring: The system shall measure, transmit, and display all analog values including calculated analog points. An analog change in value is defined as a change exceeding a preset differential value as specified. All displays and reports shall express analog values in proper engineering units with sign. The system shall accommodate up to 255 different sets of engineering unit conversions. Each engineering unit conversion shall include range, span, and conversion equation.

10.11 Logic (Virtual) Points: Logic (virtual) points shall be software points entered in the point data base which are not directly associated with a physical I/O function. Logic (virtual) points shall be analog or digital points having all the properties of real points, including alarms, without the associated hardware. Logic (virtual) points shall be defined or calculated and entered into the data base by the Contractor and shall include:

- a. Control loop setpoints.
- b. Control loop gain constants.
- c. Control loop integral constants.
- d. Summer/winter operation.
- e. Real time.
- f. Scheduled on/off times.
- g. Equipment run-time targets.

OCEGS-13952

AUGUST 1990

h. Calculated point values.

10.12 Summer-Winter Operation Monitoring: The system shall provide software to change the operating parameters, monitoring of alarm limits, and start-stop schedules for each mechanical system from summer to winter and vice versa. The software shall provide commands to applications programs to coordinate summer or winter operation.

10.13 Control Sequences and Control Loops: Operator commands shall be used to create and execute control sequences and control loops for automated control of equipment based on operational parameters including times and events, defined in the data base. The system shall prompt the operator for information necessary to create, modify, list, and delete control sequences and Proportional plus Integral (PI) control loops. The system shall prompt the operator for confirmation that the control sequence and control loop addition/modification/ deletion is correct, prior to placing it in operation. All mathematics functions required shall be available for use in creating the control sequences and control loops. Sufficient memory shall be provided to allow four control sequences and four control loops in addition to those necessary to implement the requirements specified for each RCU. Each control sequence shall accommodate up to 8 terms or devices.

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10.14 RCU Resident Applications Software: The Contractor shall provide programs as specified and as required by the I/O summary tables, and the associated sequences of operation, parameters, constraints, and interlocks as specified and shown. All applications programs shall be resident and executing in the RCU, and shall coordinate with each other, to insure that no conflicts or contentions remain unresolved. The Contractor shall coordinate the applications programs specified with the existing equipment and controls operation, and other specified requirements. A scheme of priority levels shall be provided to pre-vent interaction of a command of low priority with a command of higher priority. The system shall require the latest highest priority command addressed to a single point to be stored for a period of time longer than the longest time constraint in the ON and OFF states, insuring that the correct command will be issued when the time constraint is no longer in effect or report the rejected command. Override commands entered by the operator shall have higher priority than those emanating from applications programs.

10.14.1 Program Inputs and Outputs: The Contractor shall select the appropriate program inputs listed for each application program to calculate the required program outputs. Where the specific program inputs are not available, such as no status indication called for on the

OCEGS-13952

AUGUST 1990

I/O summary table, a "default" value shall be provided to replace the missing input, thus allowing the application programs to be tested. All analog inputs to applications programs shall have an operator adjustable deadband to preclude short cycling or hunting. Program outputs shall be real analog or digital outputs or logic (virtual) points as required to provide the specified function. The Contractor shall select the appropriate input and output signals to satisfy the requirements for direct or supervisory control as shown on the drawings. The drawings also delineate required sequences of operation, parameters, constraints and other operational information required for successful performance of the work.

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10.14.2 Coordination of Demand Limiting Program: RCUs are arranged in installations or within functional groups (islands) such that different items of equipment utilizing electrical power, steam and hot water district heat from a single metered supply are controlled by different RCUs with the meter data provided as an input to only one RCU. The Contractor shall configure the UEMCS hardware and software in such a way that the shedding of loads is coordinated within a specified functional group without using any FND communication (including transfer points). Contractor shall provide this coordination in the RCUs or at the Island Station as specified. If the Contractor requires the use of an Island Station to provide this coordination on an island the Contractor shall provide an Island Station at the island, whether or not an Island Station is specified.

10.14.3 Scheduled Start-Stop Program: This program shall start and stop equipment based on a time of day schedule for each day of the week, and on a holiday schedule. To eliminate power surges, an operator adjustable time delay shall be provided between consecutive start commands.

10.14.3.1 Program Inputs:

- a. Day of week/holiday.
- b. Time of day.
- c. Summer and winter high-low alarm limits.
- d. Summer and winter start-stop schedules.
- e. Summer or winter operation.
- f. Equipment status.

OCEGS-13952

AUGUST 1990

g. Equipment constraints.

10.14.3.2 Program Outputs (for supervisory and direct control):

a. Start signal.

b. Stop signal.

10.14.4 Optimum Start-Stop Program: This program shall start and stop equipment as specified for the scheduled start-stop program, but shall include a sliding schedule based on indoor and outdoor air conditions. The program shall take into account the thermal characteristics of the structure, indoor and outdoor air conditions using prediction software to determine the minimum time of HVAC system operation needed to satisfy space environmental requirements at the start of the occupied cycle, and determine the earliest time for stopping equipment at the day's end.

10.14.4.1 Program Inputs:

a. Day of week/holiday.

b. Time of day.

c. Summer or winter operation.

d. Equipment status.

e. Summer and winter building occupancy schedules.

f. Space temperature(s).

g. Building heating constant (operator adjustable).

h. Building cooling constant (operator adjustable).

I. OA temperature.

j. Required space temperature at occupancy (heating).

k. Required space temperature at occupancy (cooling).

l. Equipment constraints.

m. Summer and winter high-low alarm limits.

OCEGS-13952

AUGUST 1990

10.14.4.2 Program Outputs (for supervisory and direct control):

- a. Start signal.
- b. Stop signal.

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10.14.5 Electrical Power Demand Limiting Program: This program shall utilize the sliding window interval method for shedding electrical loads to prevent exceeding demand peak values (targets). The program shall continuously monitor power demand, and with prediction software, calculate a predicted power demand. When the predicted power demand exceeds a preset desired target, the program shall shut off loads on a prescheduled priority basis to reduce the connected load before the actual peak exceeds the target.

10.14.5.1 The demand limiting program shall provide four priority levels of loads. All loads in the lowest priority level shall be shed before loads in the next higher priority level. Loads shed first within a priority level shall be restored first. All loads shed in the highest priority level shall be restored before loads in lower priority levels.

10.14.5.2 The demand program shall be compatible with "time-of-day" metering. The program shall permit a minimum of six individually definable "time-of-day" demand periods in 24 hours.

10.14.5.3 Program Inputs:

- a. Day of week/holiday.
- b. Time of day.
- c. Equipment status.
- d. Peak demand limit target.
- e. Equipment priority schedules.
- f. Length of sliding window interval.
- g. Demand.
- h. Minimum space temperature during occupied periods (heating season).

OCEGS-13952

AUGUST 1990

- I. Space temperatures.
- j. Equipment constraints.
- k. Summer and winter operation.

10.14.5.4 Program Outputs:

- a. Start/stop signals. (direct control).
- b. Load shed group command to RCUs (supervisory control).

10.14.6 District Heat Demand Limiting Program: This program shall utilize the sliding window interval method for shedding hot water (or steam) district heat loads to prevent exceeding demand peak values (targets). The program shall continuously monitor the district heat water (or steam) flow rate and with prediction software, calculate a predicted flow rate demand. When the predicted flow rate demand exceeds a preset desired target, the program shall close control valves on the primary side of heat exchangers on a prescheduled priority basis to reduce the flow rate before the actual peak exceeds the target.

10.14.6.1 The demand limiting program shall provide four priority levels of loads. All loads in the lowest priority level shall be shed before loads in the next higher priority level shall be restored first. All loads shed in the highest priority level shall be restored before loads in the lower priority levels.

10.14.6.2 Program Inputs:

- a. Day of week/holiday.
- b. Time of day.
- c. Equipment status.
- d. Peak demand limit target.
- e. Heat exchanger priority schedules.
- f. Length of sliding window interval.
- g. District heat flow rate.
- h. Minimum space temperature during occupied periods (heating).

OCEGS-13952

AUGUST 1990

- I. Space temperatures.
- j. Equipment constraints.
- k. Summer and winter operation.

10.14.6.3 Program Outputs:

- a. Open/close signals (direct control).
- b. Load shed group command to RCUs (supervisory control).

10.14.7 Day-Night Setback Program: The software shall limit the rise or drop of space temperature (or specified fluid temperature) during occupied hours. Whenever the space temperature (or specified fluid temperature) is above (or below for heating) the operator assigned temperature limit, the system shall be turned on until the temperature is within the assigned temperature limit.

10.14.7.1 Program Inputs:

- a. Day of week.
- b. Time of day.
- c. Summer or winter operation.
- d. Summer and winter occupancy schedules.
- e. Equipment status.
- f. Space temperature (or specified fluid temperature).
- g. Minimum space temperature (or specified fluid temperature) during unoccupied periods.
- h. Maximum space temperature (or specified fluid temperature) during unoccupied periods.
- I. Equipment constraints.

10.14.7.2 Program Outputs:

- a. Start/stop signal (direct control).
- b. Day-night command (supervisory control).

OCEGS-13952

AUGUST 1990

10.14.8 Economizer Program: The software shall reduce the HVAC system cooling requirements when the OA dry bulb temperature is less than the return air temperature. When the OA dry bulb temperature is above the return air temperature or changeover setpoint, the OA dampers, return air dampers, and relief air dampers shall be positioned to provide minimum required OA. When the OA dry bulb temperature is below a changeover setpoint, temperature, the OA, return air, and exhaust air dampers are positioned to maintain the required mixed air temperature.

10.14.8.1 Program Inputs:

- a. Changeover dry bulb temperature.
- b. OA dry bulb temperature.
- c. Return air dry bulb temperature.
- d. OA intake damper position.
- e. Mixed air dry bulb temperature.
- f. Equipment constraints.

10.14.8.2 Program Output:

- a. Damper actuator control signal (direct control).
- b. Automatic or minimum OA damper control signal (supervisory control).

10.14.9 Ventilation-Recirculation Program: The software shall reduce the HVAC system thermal load during warm-up or cool-down cycles prior to occupancy of the building and during day/night setback operations. The OA damper shall remain closed for warm-up and cool-down cycles occurring during day-night set-back periods. During summer cool-down cycle operation prior to occupancy of the building, when the OA temperature is cooler than the space temperature, the OA and exhaust air dampers shall be allowed to open. During winter warm-up cycle operation prior to occupancy of the building, when the OA temperature is warmer than space temperature, the OA and exhaust air dampers shall be allowed to open. The OA damper and exhaust air damper shall be closed during the unoccupied mode at all other times.

10.14.9.1 Program Inputs:

- a. Day of week.

OCEGS-13952

AUGUST 1990

- b. Time of day.
- c. Summer or winter operation.
- d. Equipment status.
- e. Summer and winter occupancy schedules.
- f. OA dry bulb temperature.
- g. Space temperature.
- h. Equipment constraints.

10.14.9.2 Program Output:

- a. Damper actuator control signal (direct control).
- b. Open, automatic, and close damper control signal (supervisory control).

10.14.10 Hot Water OA Reset Program: The software shall reset the hot water temperature supplied by the boiler or converter in accordance with the OA temperature. The hot water supply temperature shall be reset downward or upward from a fixed temperature proportionally, as a function of OA temperature.

10.14.10.1 Program Inputs:

- a. Reset schedule.
- b. OA dry bulb temperature.
- c. Hot water supply temperature.
- d. Maximum hot water (HW) supply temperature.
- e. Equipment constraints.

10.14.10.2 Program Output:

- a. Valve actuator control signal (direct control).
- b. CPA signal (temperature) to local controller (supervisory control).

OCEGS-13952

AUGUST 1990

10.14.11 Lighting Control Program: The software shall turn lights off based on the time of day and the day of week, including holidays. The program shall generate additional commands at operator adjustable intervals to assure that lights are off (relay operated zoned lighting only).

10.14.11.1 Program Inputs:

- a. Day of week-holiday.
- b. Time of day.
- c. Summer and winter start-stop schedules.
- d. Equipment status.
- e. Times of day for additional off commands (where applicable).

10.14.11.2 Program Output: Off signal (supervisory or direct control).

10.14.12 Remote Boiler Monitoring and Control: The software shall remotely monitor and control boiler operation based on boiler operational data. The program shall monitor all inputs and discontinue boiler operation if any monitored point exceeds a predetermined value or changes status incorrectly. The operator shall be able to add or delete individual points from the list of points that will discontinue boiler operation.

10.14.12.1 Program Inputs:

- a. Fuel flow.
- b. Fuel pressure.
- c. Flame status.
- d. Flue gas oxygen.
- e. Flue gas temperature.
- f. Makeup flow.
- g. Furnace draft.

OCEGS-13952

AUGUST 1990

h. Flue gas carbon monoxide (over 10,000 kilograms per hour).

i. Hot water flow (hot water boilers).

j. Hot water pressure (hot water boilers).

k. Hot water supply temperature (hot water boilers).

l. Hot water return temperature (hot water boilers).

m. Hot water kWh (hot water boilers).

n. Steam flow (steam boilers).

o. Steam pressure (steam boilers).

p. Steam kWh (steam boilers).

q. Feedwater temperature (steam boilers).

r. Boiler drum level (steam boilers).

s. Steam temperature (steam boilers, superheat only).

t. Fuel oil temperatures (oil-fired boilers #4, 5, 6, fuel only).

10.14.12.2 Program Output: Boiler stop control signal (supervisory control).

10.14.13 District Heat Supply Program: The software shall control the hot water supply temperature on the secondary side of the district heat exchanger. The hot water supply temperature shall be reset downward or upward from a fixed temperature proportionally, as a function of OA temperature.

10.14.13.1 Program Inputs:

a. Hot water (HW) supply temperature (secondary side)

b. Reset schedule

c. OA dry bulb temperature

d. Maximum HW supply temperature

OCEGS-13952

AUGUST 1990

- e. Equipment constraints.

10.14.13.2 Program Output:

- a. District heat primary control valve control signal (direct control).
- b. CPA signal (temperature) to local controller (supervisory control).

10.14.14 Hot Water Distribution Program: The software shall control the hot water distribution temperature to individual building zones. The zone hot water distribution temperature shall be reset downward or upward from a fixed temperature proportionally as a function of OA temperature by modulating the respective zone mixing valve. The zone pump shall be stopped when the OA temperature exceeds the specified setpoint. When parallel pumps are used, the software shall alternate pump operation and shall start the standby pump (after a time delay) upon failure of the operating pump.

10.14.14.1 Program Inputs:

- a. Zone Hot Water distribution temperature
- b. Reset schedule
- c. OA dry bulb temperature
- d. Maximum zone hot water distribution temperature
- e. Zone pump status
- f. Equipment constraints.

10.14.14.2 Program Output:

- a. Zone mixing valve control, Zone pump start signal(s), and zone pump stop signal(s) (direct control).
- b. Zone CPA signal (temperature) to local controller (supervisory control).

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10.14.15 Domestic Hot Water Generator Program: The software shall control the domestic hot water (DHW) temperature by adjusting the

OCEGS-13952

AUGUST 1990

hot water supply control valve and/or the domestic hot water generator loading pump.

10.14.15.1 Program Inputs:

- a. Domestic hot water temperature
- b. Domestic hot water temperature setpoint

10.14.15.2 Program Outputs:

- a. Hot water supply control valve control signal and Loading Pump start/stop signal (direct control).
- b. CPA signal (temperature) to local controller (supervisory control)

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10.14.16 Heating and Ventilating Unit Program: The software shall control hot water/steam coil valve position to maintain space/supply air temperatures for heating and ventilating units. This program shall be coordinated with the ventilation-recirculation program for damper control and the scheduled or optimum start-stop program for fan control.

10.14.16.1 Program Inputs:

- a. Space temperature
- b. Space temperature setpoint
- c. Supply air temperature
- d. Supply air temperature setpoint

10.14.16.2 Program Outputs:

- a. Heating or steam coil valve control signal (direct control).
- b. CPA signal (temperature) to local controller (supervisory control).

11. ISLAND FND STANDARD INTERFACE ADAPTER

OCEGS-13952

AUGUST 1990

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11.1 General: The Island FND Standard Interface Adapter shall be in accordance with the AMEV FND specification, and shall function as the interface between the Central Station and each Island at the installation or functional group as specified and shown and shall provide [a CCITT V.24/V.28 interface for data transmission over the specified circuit-switched data communications network.] [a CCITT X.21/X.25 interface for data transmission over the specified packet-switched data communications network.] [a CCITT V.24/X.28 interface for start-stop mode data transmission over the specified packet-switched data communications network.]

11.2 Software: Software shall be provided to meet all functional requirements of this specification for FND transmission.

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12. ISLAND STATION HARDWARE:

12.1 Island Station Computer: The Island Station computer shall be a single manufacturer's standard unmodified digital computer of modular design. The word size and data buses shall be 32 bits or larger. The operating speed of the processor shall be at least 20 MHZ.

12.1.1 Memory: The computer shall contain at least 2 megabytes of usable installed random access memory.

12.1.2 Power Supply: The power supply shall provide all internal dc and ac voltages for operation. The power supply shall provide isolation and protection from power line variations, including transients. The power supply shall not exceed 500 watts in size.

12.1.3 Real Time Clock: The Real Time Clock shall be internal uninterruptible with battery backup sufficient for not less than 3 months. Accuracy shall be within one-half second per day. The Real Time Clock shall maintain time in a 24-hour format including seconds, minutes, hours, date, and month. The Real Time Clock shall be resettable by software.

12.1.4. Serial Port: A CCITT V.24/V.28 port, associated driver, and controller for connection of the RCU Portable Tester, RCU Test Set, and telephone system connection as specified shall be provided. A four position manual data switch shall be provided for switching between the RCU Portable Tester, RCU Test Set, telephone system connection, and an additional position for plug-in of a future CCITT V.24/V.28 compatible peripheral device.

OCEGS-13952

AUGUST 1990

12.1.5 Additional Serial Port: The computer shall include an additional CCITT V.24/V.28 port, associated driver, and controller for connection of a future CCITT V.24/V.28 compatible peripheral device.

12.1.6 Parallel Ports: The computer shall have two parallel ports, and associated drivers, that provide for the connection and operation of the alarm and logging printers.

12.1.7 Keyboard: A keyboard shall be furnished with the computer. The keyboard shall have a minimum 64-character standard ISO character set based on ISO IA5 and DIN 66003. The keyboard shall provide a means for the operator to interact with all Island Station functions.

12.1.8 Audible Alarm: The manufacturer's standard audible alarm shall be provided with the computer.

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12.1.9 Dial-Up Modem: [A Dial-Up MODEM operating at 1200 bps and with automatic answer and automatic originate capability shall be provided and interfaced with the computer. The MODEM shall be interfaced to the telephone system and shall be certified to meet the requirements of the local telephone system authority.] [A serial port suitable for connection to MODEMS provided by the local telephone system authority, shall be provided as specified.]

12.2 Color Monitor: The color monitor provided at the Island Station shall be a 14-inch (nominal) color monitor with a minimum of 256 colors. The screen display shall have a minimum resolution of 640 by 480 pixels. The data rate between the monitor and the computer shall be at least 9600 baud.

12.3 Telephone Network Interface:

12.3.1 The Island Station shall include MODEMS, data connecting units, or other line terminations for each communications circuit.

12.3.2 A separate communications circuit shall be provided for each DTM specified. Interfaces for connection of RF network controllers shall be provided, in accordance with the RF equipment manufacturer's requirements for radio communications between the Island Station and the Central Station.

12.4 Disk Storage:

OCEGS-13952

AUGUST 1990

12.4.1 The Island Station shall include a hard disk having a maximum average access time of 30 milliseconds. The hard disk shall provide a minimum of 66 megabytes of formatted storage.

12.4.2 The Island Station shall include a 3-1/2 or 5-1/4 inch diameter floppy disk. Floppy disk media for the Island Station shall be compatible with the Central Station floppy disk and shall provide for a minimum of 1.2 megabytes of formatted storage.

12.5 Printer: A dot matrix printer shall be provided with each Island Station. This printer shall have a minimum 96 character standard ISO character set and dot graphics capability. The printer shall have adjustable sprockets for paper width up to 15 inches and shall print at least 132 columns per line. The printer shall have a minimum speed of 200 characters per second. Character spacing shall be selectable at 10, 12 or 17 characters per inch. The printer shall utilize sprocket-fed fanfold paper. The unit shall have programmable control of top-of-form.

12.6 Magnetic Tape System: A quarter inch cartridge magnetic tape system shall be provided at the Island Station. The system capacity shall be 60 megabytes minimum per tape. Ten blank magnetic tape cartridges shall be delivered with the system. Each tape shall be computer grade, in a rigid cartridge with spring-loaded cover and write-protect switch.

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13. ISLAND STATION SOFTWARE

13.1 General: The Island Station software shall support all specified functions, plus expansion of the island to a total of 1,000 points, complete with their point database.

13.2 Island Station Operation: The Island Station shall:

- a. Operate and manage all peripheral devices.
- b. Provide file management functions for disk I/O, including creation and deletion of files, copying of files, a directory of all files including size and location of each, sequential and random ordered records.
- c. Provide printer spooling.

13.3 Disk Compress Routine: Utility software shall be provided to recover file space lost to fragmentation and operate from disk to disk and disk to tape to disk.

OCEGS-13952

AUGUST 1990

13.4 Diagnostic Programs: Diagnostic programs to report all failures of the Island Central Station and peripherals shall be provided.

13.5 Real Time Clock Synchronization: The Island Station real time clock shall be synchronized with the Central Station at least once per day automatically without operator intervention and without requiring system shutdown. The Island Station shall synchronize the RCU's real time clock at least once per day automatically without operator intervention and without requiring system shutdown.

13.6 Analog Totalization: Any analog or calculated point shall be operator assignable to the totalization program. Analog values shall be totalized within a given time period. This time period shall be defined uniquely for each point. At the end of the period, totals shall be stored for future reference. Totalization shall then restart from zero for the next time period. The program shall keep track of the peak and total value measured during the current period and for the previous period. The operator shall be able to initiate a summary of all totalization information on a point, unit, building, or entire island. The operator shall be able to set or reset each totalized value individually. The operator shall be able to define, modify, or delete the time period on-line.

13.7 Energy Totalization: The system shall calculate the heat energy in kWh, for each energy source consumed by the mechanical systems specified, totalize the calculated kWh, the instantaneous rate in kW, and store totals in kWh. The kWh calculated shall be totalized for an adjustable time period. The time period shall be defined uniquely for each kWh totalization. The system shall allow the operator to define or modify time periods on-line.

13.8 Trending: Any analog or calculated point shall be operator assignable to the trend program. A minimum of eight points shall be sampled at individually assigned intervals, selectable between one minute and 24 hours. A minimum of the most recent 96 samples of each trended point shall be stored. The sample intervals shall be able to be defined, modified, or deleted on-line.

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13.9 Command Software: The system shall accept the [German] [] language(s) operator commands for defining and selecting points, parameters, graphics, report generation, and all other functions associated with operation. The operator commands shall be usable from the Island Station computer keyboard with individual operator passwords as specified.

OCEGS-13952

AUGUST 1990

13.9.1 Operator's commands shall be full words and acronyms selected to allow operators to use the system without extensive training or data processing back-grounds. The system shall prompt the operator in full words and acronyms for all required information identifying acceptable command formats. The operator's response shall be a word, phrase, or acronym including parameters where required.

13.9.2 The system shall supervise operator inputs to ensure they are correct for proper execution. Operator input assistance shall be provided whenever a command cannot be executed because of operator input errors. The system shall explain to the operator why the command cannot be executed. Conditions for which operator error assist messages shall be generated include:

- a. The command used is incorrect or incomplete.
- b. The operator is restricted from using that command.
- c. The command addresses a point which is disabled or out of service.
- d. The command addresses a point which does not exist.
- e. The command would violate constraints.

13.9.3 The operator's commands shall provide the means for entry of control and monitoring commands, and for retrieval of information. Processing of operator commands shall commence within 5 seconds of entry, with some form of acknowledgment provided at that time. The operator's commands entered at an island station shall perform tasks associated with points at the same island including:

- a. Request a display of any digital, analog, or accumulator point, or any group of related points.
- b. Startup and shutdown selected systems or devices.
- c. Initiate reports.
- d. Modify time and event scheduling.
- e. Modify analog limits.
- f. Adjust setpoints.
- g. Adjust control loop gain constant.

OCEGS-13952

AUGUST 1990

- h. Adjust control loop integral constant.
- I. Select manual or automatic control modes.
- j. Enable and disable individual points at individual RCUs.
- k. Enable and disable individual RCUs.
- l. Define points.
- m. Print operator's commands at time of entry on the printer.
- n. Generate and format reports.

13.9.4 Five levels of addressing for identification shall be provided as follows:

- a. Point the individual sensor or control device within a unit.
- b. Unit the unit that a point is associated with, such as an AHU.
- c. Building the building that a point is located in or near.
- d. Area the area that a building is located in or near.
- e. Installation the Military Community.

13.9.5 A minimum of 4 passwords shall be usable at the Island Station. The system shall display the operator's name or initials on the monitor. The system shall print the operator's name or initials, action, date, and time on the printer at log-on and log-off. The password shall not be displayed or printed.

13.10 Data Base Definition: Software shall be provided to define and modify each point in the data base in the Island Station and RCUs using operator commands. The definition shall include all physical parameters and constraints associated with each point. Each data base item shall be callable for display.

13.11 Report Generator:

13.11.1 General: Software shall be provided with commands to generate and format reports for displaying, printing, and storing on

OCEGS-13952

AUGUST 1990

disk and tape. Reports shall be stored by type, date, and time. The destination of each report shall be selectable by the operator. Reports shall use data base values and parameters, values calculated using the data base, and reports stored on disk or tape. Reports shall be spooled allowing the printing of one report to be complete before the printing of another report commences. Parameters used in reports shall be assignable by the operator. Dynamic operation of the system shall not be interrupted to generate a report. The report shall contain the time and date when the data point sample was taken, and the time and date when the report was printed.

13.11.2 Reports:

13.11.2.1 Status Report: A report to list current status or analog value of any point in the system including:

a. An individual equipment item, sensor or control device.

b. A list of equipment, sensors, or control devices, by category, such as building, unit, RCU, or type.

13.11.2.2 Profile Reports: The software shall provide for generating profile reports by sampling and storing defined parameters for an operator selected time interval, such as an interval of 15 minutes for a period of 1 month and shall include:

a. Power consumption (value vs time).

b. Power demand (value vs time).

c. Temperatures (value vs time).

d. Equipment subsystem profiles (value vs value or value vs time). Sixteen profile reports shall be provided each with 1000 samples of up to 12 parameters.

13.11.2.3 Electrical Power Utilization Report: An electrical power utilization summary, operator selectable for individual meters, any group of meters, and all meters for an operator selected time period. The report shall be automatically printed at the end of each summary period and shall include:

a. Total period consumption.

OCEGS-13952

AUGUST 1990

b. Demand interval peak for the period, with time of occurrence.

c. Consumption over each demand interval.

d. OA temperature and relative humidity taken once during each demand interval.

e. Calculated degree days.

13.11.2.4 Energy Utilization Report: An energy utilization summary, operator selectable, for individual meters connected to the UEMCS. The report shall include:

a. Beginning and ending dates and times.

b. Total energy usage for the current and previous day.

c. Total energy usage for the current and previous month.

d. Maximum rate of consumption for the current and previous day.

e. Maximum rate of consumption for the current and previous month.

f. OA temperature high, low, and average.

g. Calculated degree days.

13.11.2.5 Alarm Report: All outstanding alarms including time of occurrence.

13.11.2.6 Run-Time Reports: A report totalizing the accumulated run-time of individual pieces of equipment. The operator shall be able to select the following subsets of equipment:

a. Individual equipment items.

b. Equipment type, such as fans and pumps.

c. Specific equipment sizes by types, such as all motors over 20 HP.

d. Equipment by physical grouping. The software shall maintain statistics on a number of equipment items equal to the number

OCEGS-13952

AUGUST 1990

of digital inputs and outputs. Run-time shall be totaled up to 999 hours. Reports shall be generated on equipment which has reached the target run-time specified in the data base. The software will provide for manual and automatic reset, operator selectable and settable for each individual run-time totalized, to zero upon generation of the report.

13.11.2.7 Optimum Start-Stop Report: A list of all systems and buildings not meeting occupancy temperature requirements within plus or minus 20 minutes of the designated occupancy time and those systems buildings meeting the occupancy temperature earlier than 20 minutes prior to the designated occupancy time, printed daily or upon request. The report shall include:

- a. System and building identification.
- b. Building occupancy schedule.
- c. Actual start or stop time.
- d. Calculated start or stop time.
- e. Space temperature at beginning or end of occupancy.
- f. OA temperature at beginning or end of occupancy.

13.11.2.8 Outside Temperature Profile Report: The outside temperature profile report shall be operator selectable for any specific time period. The report shall include:

- a. Daily high outside temperature.
- b. Daily low outside temperature.
- c. Daily average outside temperature.
- d. Calculated degree days.

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13.11.2.9 Static Data Base Reports: A listing of the values of fixed parameters and constraints defining the characteristics of the system and I/O functions. Provide operator commands to list the entire static data base or to list an operator selected building, unit, point, or RCU. Each value listed shall be identified in the [German] [] language(s).

OCEGS-13952

AUGUST 1990

13.11.2.10 DTM Circuit Report: A listing of all DTM circuits from the Island Station to RCUs and from each RCU to its remote I/O functions. The report shall include for each DTM circuit:

- a. Operator selected number (1-99) of retransmissions attempts.
- b. Total number of transmissions attempted (0-64,000).
- c. Present consecutive retrys (in progress) (1-99).
- d. Total number of retrys (cumulative to 32,000).
- e. Status of DTM circuit (enabled or disabled).

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13.12 Monitor Display: The monitor shall display all information necessary to support the requirements specified, including:

- a. Operator commands.
- b. Alarm notification.
- c. Reports.

13.13 Printer Output: Formats for printed data shall be consistent with those used in alphanumeric displays. Descriptions printed shall be identical to those presented on the monitor. All monitor displays shall be able to be printed to the logging printer as a screen image.

13.14 Alarms:

13.14.1 General: The software shall notify the operator of the occurrence of an alarm condition. The most recent 250 alarms shall be stored and shall be recallable by the operator using the report generator. All alarms shall be printed on the printer and be displayed on the monitor. Alarm messages shall take precedence over reports, and reports shall take precedence over logging of operator actions. Alarms shall be displayed in chronological order with the oldest unacknowledged alarm displayed first. Operator acknowledgment of one alarm shall not be considered as acknowledgment of any other alarm nor shall it inhibit reporting of subsequent alarms. Four commands shall be provided, allowing an operator with a high level password to (1) enable or (2) disable automatic silencing of all alarms, and to (3) enable or (4) disable automatic acknowledgment of all alarms. Alarm data to be displayed and printed shall include:

OCEGS-13952

AUGUST 1990

- a. Identification of alarm.
- b. Date and time to the nearest minute of occurrence.
- c. Device or sensor type.
- d. Limit exceeded (if analog).
- e. Engineering units.
- f. Current value or status.
- g. Alarm class.
- h. Alarm messages.

13.14.2 Digital Alarms: Digital alarms shall be subject to immediate reporting, within the alarm response time, at the Island Station regardless of other considerations such as the overall time constant associated with a controlled system or process.

13.14.3 Analog Alarms: Analog alarms shall be subject to immediate reporting, within the alarm response time, at the Island Station regardless of other considerations such as the overall time constant associated with a controlled system or process. All operator-requested analog displays, reports, and summaries shall flag each analog point in alarm.

13.14.4 Pulse Accumulator Alarms: Pulse accumulator alarms shall be subject to immediate reporting at the Island Station.

13.14.5 Alarm Messages: A unique message with a field of 60 characters shall be provided for each alarm. Assignment of messages to a point shall be an operator editable function. Secondary messages shall be assignable by the operator for printing to provide further information, such as telephone lists or maintenance functions, and shall be editable by the operator. The system shall provide for 100 secondary messages with a field of 4 lines of 60 characters each.

13.14.6 Alarm Classes: Classes of alarms, established for each item during the definition process, include:

- a. Class 1: Display and print at occurrence and at return-to-normal.

OCEGS-13952

AUGUST 1990

b. Class 2: Display and print a audible alarm at occurrence. Operator acknowledgment shall end audible alarm. Print at return-to-normal.

13.14.7 RCU, I/O function, and DTM Circuit Alarms: The system shall super-vise each RCU, I/O function and DTM circuit for alarm reporting, including:

- a. RCU or I/O function not responding.
- b. RCU or I/O function responding (return to normal).
- c. RCU /Island Station DTM circuit high error rate.
- d. RCU /I/O function DTM circuit high error rate.
- e. RCU /Island Station RTC error more than one minute (adjustable).
- f. Intrusion alarm.
- g. Off line control panel activated.
- h. On line control panel activated.
- i. RCU failure self-diagnostics activated.
- j. Point not responding to command.
- k. Point change of state without command.

13.15 System Reaction: No more than 10 seconds shall lapse from the time a digital status alarm or analog alarm occurs at an RCU until the change is displayed at the Island Station. The total system response time from initiation of a control action command from the Island Station, to display of the resulting status change on the Island Station shall not exceed 20 seconds assuming a zero response time for operation of the RCU control device. Where dial-up telephone lines are used for data transmission between RCUs and the Island Station, the time required to establish a connection through the telephone switching station is excluded from these time limits.

13.16 Data Base: The data base shall consist of two parts, the real time data base and the static data base.

OCEGS-13952

AUGUST 1990

13.16.1 The real time data base includes those variables which change with time or conditions including all digital and analog inputs.

13.16.2 The static data base includes those fixed parameters and constraints which define the characteristics of the system and I/O functions such as alarm limits, start/stop times, point name, RCU channel address, and sensor span.

13.16.3 A copy of the real time and static data base shall reside on the hard disk for the Island Station. They shall be updated automatically whenever a change occurs.

13.17 System Start-Up:

13.17.1 General: The system shall automatically start upon application of power, and shall be in full operation as specified within 2 minutes.

13.17.2 Recovery From Power Failure: When a power failure occurs at the Island Station, the system shall automatically start upon restoration of power as specified.

13.18 RCU Programming: The system shall include a programming function in the Island Station for a user to create, modify, and test programs for RCU RAM resident programs, constraints, and data base parameters for execution in RCUs of the same manufacturer. Capability shall be provided to accomplish:

a. Creation, modification, and testing of programs. Modular application software, control sequences, and PI control loops shall be used in the development of programs.

b. Conversion of source programs into executable object code.

c. Editing source code.

d. Debugging operations.

e. Assignment of operational parameters resident in the RCU.

f. Save and retrieve source and executable object code.

g. Load RCU-RAM based information and programs into the RCU Portable Tester for loading directly into the RCU.

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OCEGS-13952

AUGUST 1990

14. CENTRAL STATION HARDWARE

14.1 Central Station Computer: The Central Station computer shall function as the overall system supervisor, control peripheral devices, and perform functions associated with operator interactions, alarm reporting, and logging of events. The computer shall be a single manufacturer's standard unmodified digital computer of modular design. The word size and data buses shall be 32 bits or larger. The operating speed of the processor shall be at least 20 MHZ.

14.1.1 Memory: The computer shall contain at least 4 megabytes of usable installed random access memory, expandable to at least 8 megabytes of usable random access memory without additional chassis or power supplies.

14.1.2 Power Supply: The power supply shall provide all internal dc and ac voltages for operation. The power supply shall provide isolation and protection from power line variations, including transients. The power supply shall not exceed 500 watts in size.

14.1.3 RTC: The system RTC shall be internal uninterruptible with battery backup sufficient for not less than 3 months. Accuracy shall be within one-half second per day. The RTC shall maintain time in a 24-hour format including seconds, minutes, hours, date, and month. The RTC shall be resettable by soft-ware.

14.1.4 Serial Port: A CCITT V.24/V.28 port, associated driver, and controller for connection of the RCU Portable Tester, RCU Test Set, and telephone system connection as specified shall be provided. A four position manual data switch shall be provided for switching between the RCU Portable Tester, RCU Test Set, telephone system connection, and an additional position for plug-in of a future CCITT V.24/V.28 compatible peripheral device.

14.1.5 Additional Serial Port: The computer shall include an additional CCITT V.24/V.28 port, associated driver and controller for connection of a future CCITT V.24/V.28 compatible peripheral device.

14.1.6 Parallel Ports: The computer shall have two parallel ports, and associated drivers, that provide for connection and operation of the alarm and logging printers.

14.1.7 Keyboard: A keyboard shall be furnished with the computer. The keyboard shall have a minimum 64-character standard ISO character set based on ISO-IA5 and DIN 66003. The keyboard shall provide a means for the operator to interact with all Central Station functions.

OCEGS-13952

AUGUST 1990

14.1.8 Enhancement Hardware: Enhancement hardware such as special function keys, mouse, or light pen shall be provided for frequently used operator commands including Start/Enable, Stop/Disable, Display Diagram, Setpoint/Limits, Auto/Override, Print/Report, Modify Schedule, Confirm Action, Cancel Action, and Help.

14.1.9 Audible Alarm: The manufacturer's standard audible alarm shall be provided with the computer.

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14.1.10 Dial-Up Modem: [A modem operating at 1200 bps and with automatic answer and automatic originate capability shall be provided and interfaced with the computer. The modem shall be interfaced to the telephone system and shall be certified to meet the requirements of the local telephone system authority.] [A telephone system connection device with CCITT V.24/V.28 interface shall be provided and interfaced with the computer. The telephone system connection device shall be suitable for connection to GFE modems obtained from the local telephone system authority, type as specified.]

14.2 Color Monitor: The color monitor provided at the Central Station shall be a 14-inch (nominal) color monitor with a minimum of 256 colors. The screen display shall have a minimum resolution of 640 by 480 pixels. The data rate between the monitor and the computer shall be at least 9600 baud.

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14.3 Central Station FND Standard Interface Adapter:

14.3.1 The Central Station shall include an FND Standard Interface Adapter. The FND Standard Interface Adapter shall be in accordance with the AMEV FND specification.

14.3.2 The FND Standard Interface Adapter shall translate all communications and data exchange between the Central Station and Islands using the format required by the AMEV FND Specifications. The FND Standard Interface Adapter shall be interfaced to the Central Station computer and shall provide [a CCITT V.24/V.28 interface for data transmission over the specified circuit-switched data communications network.] [a CCITT X.21/X.25 interface for data transmission over the specified packet-switched data communication network.] [a CCITT V.24/X.28 interface for start-stop mode data transmission over the specified packet-switched data communications network.]

14.4 Telephone Network Interface:

OCEGS-13952

AUGUST 1990

14.4.1 The Central Station shall include modems, data connection units, or other line terminations for each communications circuit.

14.4.2 A separate communications circuit shall be provided for each DTM specified. Interfaces for connection of RF network controllers shall be provided, in accordance with the RF equipment manufacturer's requirements for radio communications between the Central Station and Remote Sites.

14.5 Disk Storage:

14.5.1 The Contractor shall provide a hard disk having a maximum average access time of 18 milliseconds. The hard disk shall provide a minimum of 150 megabytes of formatted storage.

14.5.2 The Central Station shall include a 3-1/2 or 5-1/4 inch diameter floppy disk. Floppy disk media for the Central Station shall be compatible with the Island Station floppy disk, and shall provide for a minimum of 1.2 megabytes of formatted storage.

14.6 Printers: Separate identical dot matrix printers shall be provided for the logging and alarm functions. Each printer shall have a minimum 96 character standard ISO character set based on ISO IA5 and DIN 66003 and have dot graphics capability. The unit shall have adjustable sprockets for paper width up to 15 inches and shall print at least 132 columns per line. The printer shall have a minimum speed of 200 characters per second. Character spacing shall be selectable at 10, 12, or 17 characters per inch. The printer shall utilize standard form size, sprocket-fed fanfold paper, and have multiple copy capability. The unit shall have programmable control of top-of-form.

14.7 Magnetic Tape System: A quarter-inch cartridge magnetic tape system shall be provided at the Central Station. The system capacity shall be 60 megabytes minimum per tape. Ten blank magnetic tape cartridges shall be delivered with the system. Each tape shall be computer grade, in a rigid cartridge with spring-loaded cover and write-protect switch.

14.8 Central Station Console and Accessories: The Contractor shall provide a metallic, desk-type console, a system operator's swivel chair on casters, and printer stands with paper trays. Seven thousand sheets of printer paper and 12 ribbons shall be furnished after successful completion of the endurance test. All consoles and equipment cabinets shall be color coordinated. A locking cabinet approximately 2 meters high, 1 meter wide, one-half to one meter deep with three adjustable shelves, and two storage racks for storage of disks, tapes, printouts,

OCEGS-13952

AUGUST 1990

printer paper, ribbons, manuals, and other documentation shall be provided.

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15. CENTRAL STATION SOFTWARE:

15.1 General: The Central Station software shall support all specified functions, plus expansion of the system to a total of 16,000 points, complete with their point database.

15.2 Central Station Operation: The Central Station shall:

a. Operate and manage peripheral devices.

b. Provide file management functions for disk I/O, including creation and deletion of files, copying of files, a directory of all files including size and location of each, sequential and random ordered records.

c. Provide printer spooling.

15.3 Disk Compress Routine: Utility software shall be provided to recover file space lost to fragmentation and operate from disk to disk and disk to tape to disk.

15.4 Diagnostic Programs: Diagnostic programs to report all failures of the Central Station and peripherals shall be provided.

15.5 Real Time Clock Synchronization: The Central Station shall provide real time updates to Island Station and RCUs at least once per day automatically without operator intervention and without requiring system shutdown.

15.6 Analog Totalization: Any analog or calculated point shall be operator assignable to the totalization program. Analog values shall be totalized within a given time period. This time period shall be defined uniquely for each point. At the end of the period, store the totals for future reference. Totalization shall then restart from zero for the next time period. The program shall keep track of the peak and total value measured during the current period and for the previous period. The operator shall be able to initiate a summary of all totalization information on a point, unit, building, an entire island, or entire system. The operator shall be able to set or reset each totalized value individually. The operator shall be able to define, modify, or delete the time period on-line.

OCEGS-13952

AUGUST 1990

15.7 Energy Totalization: The system shall calculate the heat energy in kWh, for each energy source consumed by the mechanical systems specified, totalize the calculated kWh, the instantaneous rate in kW, and store totals in kWh. The kWh calculated shall be totalized for an adjustable time period. The time period shall be defined uniquely for each kWh totalization. The system shall allow the operator to define or modify time periods on-line.

15.8 Trending: Any analog or calculated point shall be operator assignable to the trend program. A minimum of the most recent 96 samples of each trended point shall be stored. The sample intervals shall be able to be defined, modified, or deleted on-line.

(Q)

15.9 Command Software: The system shall accept the [German] [] language(s) operator commands for defining and selecting points, parameters, graphics, report generation, and all other functions associated with operation of the UEMCS. The operator commands shall be usable from the Central Station computer keyboard with individual operator passwords as specified.

15.9.1 Operator's commands shall be full words and acronyms selected to allow operators to use the system without extensive training or data processing back-grounds. The system shall prompt the operator in full words and acronyms for all required information identifying acceptable command formats. The operator's response shall be a word, phrase, or acronym including parameters where required.

15.9.2 The system shall supervise operator inputs to ensure they are correct for proper execution. Operator input assistance shall be provided whenever a command cannot be executed because of operator input errors. The system shall explain to the operator in full words and phrases why the command cannot be executed. Conditions for which operator error assist messages shall be generated include:

- a. The command used is incorrect or incomplete.
- b. The operator is restricted from using that command.
- c. The command addresses a point which is disabled or out of service.
- d. The command addresses a point which does not exist.
- e. The command would violate constraints.

OCEGS-13952

AUGUST 1990

15.9.3 The system shall implement the following enhancements by use of special function keys, mouse, or light pen, in addition to all other command inputs specified:

a. HELP: used to produce a display of all commands available to the operator. The HELP command, followed by a specific command shall produce a short explanation of the purpose, use, and system reaction to that command.

b. START/ENABLE: used to manually start equipment and to enable monitoring and control components such as RCU or data point.

c. STOP/DISABLE: used to manually stop equipment and to disable monitoring and control components.

d. DISPLAY DIAGRAM: used to display diagrams of specific utility systems or other systems as specified.

e. AUTO/OVERRIDE: used to override or return a point to automatic operation.

f. PRINT REPORT: allows the operator to initiate printing of reports.

g. CONFIRM ACTION: used to confirm that the desired command sequence has been correctly entered and is to be executed.

h. CANCEL ACTION: performs the opposite function of the CONFIRM ACTION, usable at any time prior to executing CONFIRM ACTION.

15.9.4 The operator's commands shall provide the means for entry of control and monitoring commands, and for retrieval of information. Processing of operator commands shall commence within 5 seconds of entry, with some form of acknowledgment provided at that time. The operator's commands shall perform tasks including:

a. Request a display of any digital, analog, or accumulator point, or any group of related points in the system.

b. Startup and shutdown selected systems or devices.

c. Initiate reports.

d. Request graphic displays.

e. Modify time and event scheduling.

OCEGS-13952

AUGUST 1990

- f. Modify analog limits.
- g. Adjust setpoints.
- h. Adjust control loop gain constant.
- I. Adjust control loop integral constant.
- j. Select manual or automatic control modes.
- k. Enable and disable individual points at individual RCUs.
- l. Enable and disable individual RCUs.
- m. Define points.
- n. Print operator's commands at time of entry on the logging printer.
- o. Generate and format reports.

15.9.5 Five levels of addressing for identification shall be provided as follows:

- a. Point the individual sensor or control device within a unit.
- b. Unit the unit that a point is associated with, such as an AHU.
- c. Building the building that a point is located in or near.
- d. Area the area that a building is located in or near.
- e. Installation the Military Community.

15.9.6 A minimum of 4 passwords shall be usable at the Central Station. The system shall display the operator's name or initials in the CRT display first field. The system shall print the operator's name or initials, action, date, and time on the logging printer at log-on and log-off. The password shall not be displayed or printed.

15.10 Data Base Definition: Software shall be provided to define and modify each point in the data base in the Central Station and RCUs using operator commands. The definition shall include all physical parameters and constraints associated with each point. Each data base

OCEGS-13952

AUGUST 1990

item shall be callable for display. The Central Station data base shall contain all points including those in existing UEMCS as specified and as shown.

15.11 Report Generator:

15.11.1 General: Software shall be provided with commands to generate and format reports for displaying, printing, and storing on disk and tape. Reports shall be stored by type, date, and time. The destination of each report shall be selectable by the operator. Reports shall use data base values and parameters, values calculated using the data base, and reports stored on disk or tape. Reports shall be spooled allowing the printing of one report to be complete before the printing of another report commences. Parameters used in reports shall be assignable by the operator. Operation of the system shall not be interrupted to generate a report. The report generation mode, either periodic automatic or request, shall be operator assignable. The report shall contain the time and date when the sample was taken, and the time and date when the report was printed.

15.11.2 Periodic Automatic Report Modes: The system shall allow for specifying, modifying, or inhibiting the report to be generated, the time the initial report is to be generated, the time interval between reports, and the output peripheral.

15.11.3 Request Report Mode: The system shall allow for the operator to request at any time an immediate printout of any report.

15.11.4 Reports:

15.11.4.1 Status Report: The system shall include software to produce re-ports on the current status of any equipment or parameters in the data base, including:

- a. An individual equipment item sensor or control device.
- b. A list of equipment, sensors, or control devices, by category, such as building, unit, RCU, or type.

15.11.4.2 Profile Reports: The software shall provide for generating profile reports by sampling and storing defined parameters on an operator assignable and selectable time interval basis such as an interval of 15 minutes for a period of 1 month and shall include:

- a. Power consumption (value vs time).

OCEGS-13952

AUGUST 1990

- b. Power demand (value vs time).
- c. Energy utilization (value versus time).
- d. Temperatures (value vs time).
- e. Equipment subsystem profiles (value vs value or value vs time). Sixteen profile reports shall be provided each with 1000 samples of up to 12 parameters.

15.11.4.3 Electrical Power Utilization Report: An electrical power utilization summary, operator selectable for individual meters, any group of meters, and all meters on a daily and a monthly basis. The report shall be automatically printed at the end of each summary period and shall include:

- a. Total daily consumption.
- b. Total monthly consumption for period beginning on an operator selectable day of the month.
- c. Demand interval peak for the month and day, with time of occurrence.
- d. Consumption over each demand interval.
- e. OA temperature and relative humidity taken once during each demand interval.
- f. Calculated degree days.

15.11.4.4 Energy Utilization Report: An energy utilization summary, operator selectable, for a point, unit, building, area, installation, and the entire UEMCS. The report shall include:

- a. Beginning and ending dates and times.
- b. Total energy usage for the current and previous day.
- c. Total energy usage for the current and previous month.
- d. Maximum rate of consumption for the current and previous day.
- e. Maximum rate of consumption for the current and previous month.

OCEGS-13952

AUGUST 1990

f. OA temperature high, low, and average.

g. Calculated degree days.

15.11.4.5 Alarm Report: All outstanding alarms by building and unit, including time of occurrence.

15.11.4.6 Lockout Report: All control points disabled, including time disabled, and identification of operator disabling the control point.

15.11.4.7 Run-Time Reports: A report totalizing the accumulated run-time of individual pieces of equipment. The operator shall be able to select the following subsets of equipment:

a. Individual equipment items.

b. Equipment type, such as fans and pumps.

c. Specific equipment sizes by types, such as all motors over 20 HP.

d. Equipment by physical grouping. The software shall maintain statistics on a number of equipment items equal to the number of digital inputs and outputs. Run-time shall be totaled up to 999 hours. Reports shall be generated on equipment which has reached the target run-time specified in the data base. The software will provide for manual and automatic reset, operator selectable and settable for each individual run-time totalized, to zero upon generation of the report.

15.11.4.8 Optimum Start-Stop Report: A list of all systems and buildings not meeting occupancy temperature requirements within plus or minus 20 minutes of the designated occupancy time and those systems buildings meeting the occupancy temperature earlier than 20 minutes prior to the designated occupancy time, printed daily or upon request. The report shall include:

a. System and building identification.

b. Building occupancy schedule.

c. Actual start or stop time.

d. Calculated start or stop time.

OCEGS-13952

AUGUST 1990

- e. Space temperature at beginning or end of occupancy.
- f. OA temperature at beginning or end of occupancy.

15.11.4.9 Out-Of-Service Report: A report to list out-of-service devices in the Central Station, and for each DTM circuit, Island Stations, and each RCU.

15.11.4.10 Outside Temperature Profile Report: The outside temperature profile report shall be operator selectable for any specific time period. The report shall include:

- a. Daily high outside temperature.
- b. Daily low outside temperature.
- c. Daily average outside temperature.
- d. Calculated degree days.

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15.11.4.11 Static Data Base Reports: A listing of the values of fixed parameters and constraints defining the characteristics of the system and I/O functions. Provide operator commands to list the entire static data base or to list an operator selected building, unit, point, or RCU. Each value listed shall be identified in [German] [] language(s).

15.11.4.12 DTM Circuit Report: A listing of all DTM circuits from the Central Station to RCUs and from each RCU to remote I/O functions. The report shall include for each DTM circuit:

- a. Operator selected number (1-99) of retransmissions attempts.
- b. Total number of transmissions attempted (0-64,000).
- c. Present consecutive retrys (in progress) (1-99).
- d. Total number of retrys (cumulative to 32,000).
- e. Status of DTM circuit (enabled or disabled).

15.12 Monitor Display:

OCEGS-13952

AUGUST 1990

15.12.1 The monitor shall display all information and graphics to support the requirements as specified, including:

- a. Operator commands.
- b. Alarm notification.
- c. Reports.
- d. System graphics for each system, with real time data.
- e. Curve plotting of profile reports.

15.12.2 System Graphics Implementation: System graphics displays shall include real time data integrated into the display. The schematics shown are to be used as a guide for preparing the displays. Each system schematic shall be included as a separate display keyed to the building in which it is installed. Displays of all systems and points shown in the I/O summary tables and elsewhere shall be included. Different colors shall be used for the various components and real time data. Colors shall be uniform on all displays. When the display is active on the operator's console, the data associated with that display shall be updated within 10 seconds of the digital status change or the analog change in excess of the analog change differential. When a point is in alarm, the representation for that point shall be red blinking until acknowledged, and shall be steady red until the alarm condition no longer exists. Colors shall be used to allow rapid recognition and ease of interaction. Any real time data which is not current, due to Central Station to RCU communications failure, Island Station failure, RCU failure, or point out of service shall be highlighted or flagged.

15.12.3 System Graphics Software: The system graphics software shall accomplish the following:

- a. Create a new graphic.
- b. Modify a portion of a graphic.
- c. Delete a graphic.
- d. Call up a graphic.
- e. Cancel the display of a graphic.
- f. Assign conditions which automatically initiate the display.

OCEGS-13952

AUGUST 1990

- g. Overlay alphanumerics and graphics.
- h. Save new, modified, or existing graphics as new graphics.
- i. Integrate real time data with the display.
- j. Define the background color.
- k. Define the foreground color.
- l. Locate the symbols.
- m. Position and edit alphanumeric descriptors.
- n. Establish connecting lines.
- o. Establish sources of latest data and location of their readouts.
- p. Display analog data to at least three significant digits plus sign.
- q. Cursor control (up, down, right, left).
- r. Create and display alphanumeric displays.
- s. Create and display reports.
- t. Plot curves based on profile report data.

15.12.4 System Graphics Symbols: The system graphics software shall include a library of the symbols listed, plus 100 percent expansion. Symbols shall conform to DIN 19227 and DIN 40700 through DIN 40722 where applicable. The software shall allow the operator to create, modify, delete, call-up, list, and store display symbols. A library of callable display symbols shall be furnished, including:

- a. Pump: Right hand (RH), Left hand (LH), Upflow (U), Downflow (D).
- b. Valves, Two-Way: Horizontal (H), Vertical (V).
- c. Valve, Three-Way: H, V.
- d. Flow Element: H, V.

OCEGS-13952

AUGUST 1990

- e. Temperature Sensor: H, V.
- f. Pressure Sensor: H, V.
- g. Humidity Sensor: H, V.
- h. Air Handling Unit, Single Deck.
- I. Air Handling Unit, Double Deck.
- j. Fan: RH, LH, U, D.
- k. Chiller.
- l. Boiler.
- m. Vertical piping and ductwork.
- n. Horizontal piping and ductwork.
- o. Unit heater.
- p. Pressure reducing valve: H, V.
- q. Damper: H, V.
- r. Electric meter.
- s. Limit switch: H, V.
- t. Flow switch: H, V.
- u. Temperature switch: H, V.
- v. Pressure switch.
- w. Coil: H, V.
- x. Solenoid valve: H, V.
- y. Filter: H, V.
- z. Condensing unit.
- aa. Cooling tower.

OCEGS-13952

AUGUST 1990

bb. Hot water converter.

cc. Custom symbols as specified.

15.13 Printer Output: Formats for printed data shall be consistent with those used in alphanumeric displays. Descriptions printed shall be identical to those presented on the monitor. All monitor displays shall be able to be printed to the logging printer as a screen image.

15.14 Alarms:

15.14.1 General: The software shall notify the operator of the occurrence of an alarm condition. The most recent 250 alarms shall be stored and shall be recallable by the operator using the report generator. All alarms shall be printed on the alarm printer and be displayed on the monitor. Alarm messages shall take precedence over reports, and reports shall take precedence over logging of operator actions. Alarms shall be displayed in chronological order with the oldest alarm displayed first. Transmission of alarms in the data base of an Island Station or RCUs to the Central Station shall be selected or suppressed by the operator in accordance with the AMEV FND Specifications. Alarm data to be displayed and printed shall include:

- a. Identification of alarm.
- b. Date and time of occurrence.
- c. Device or sensor type.
- d. Limit exceeded (if analog).
- e. Engineering units.
- f. Current value or status.
- g. Alarm class.
- h. Alarm messages.

15.14.2 Digital Alarms: Digital alarms shall be subject to immediate re-reporting at the Central Station regardless of other considerations such as the overall time constant associated with a controlled system or process.

15.14.3 Analog Alarms: Analog alarms shall be subject to immediate reporting at the Central Station regardless of other

OCEGS-13952

AUGUST 1990

considerations such as the overall time constant associated with a controlled system or process. All operator-requested analog displays, reports, and summaries shall flag each analog point in alarm.

15.14.4 Pulse Accumulator Alarms: Pulse accumulator alarms shall be subject to immediate reporting at the Central Station.

15.14.5 Alarm Messages: A unique message with a field of 60 characters shall be provided for each alarm. Assignment of messages to a point shall be an operator editable function. Secondary messages shall be assignable by the operator for printing to provide further information, such as telephone lists or maintenance functions, and shall be editable by the operator. The system shall provide for 100 secondary messages with a field of 4 lines of 60 characters each.

15.14.6 RCU, I/O function and DTM Circuit Alarms: The system shall supervise each RCU, I/O function and DTM circuit for alarm reporting, including:

- a. RCU or I/O function not responding.
- b. RCU or I/O function responding (return to normal).
- c. RCU/Central Station DTM circuit high error rate.
- d. RCU/I/O function DTM circuit high error rate.
- e. RCU/Central Station RTC error more than one minute (adjustable).
- f. Intrusion alarm.
- g. Off line control panel activated.
- h. On line control panel activated.
- i. RCU failure self-diagnostics activated.
- j. Point not responding to command.
- k. Point change of state without command.

15.15 Data Base: The data base shall consist of two parts, the real time data base and the static data base.

OCEGS-13952

AUGUST 1990

15.15.1 Real-Time Data Base: Those variables which change with time or conditions including all digital and analog inputs.

15.15.2 Static Data Base: Those fixed parameters and constraints which define the characteristics of the system and I/O functions such as alarm limits, start/stop times, point name, RCU channel address, and sensor span. The static data base shall reside in the rigid disk system for the Central Station.

15.15.3 A copy of the Real Time and static data base shall be reside on the hard disk for the Central Station. They shall be updated automatically whenever a change occurs.

15.16 System Start-Up:

15.16.1 General: The system shall automatically start upon application of power, and shall be in full operation as specified within 2 minutes.

15.16.2 Recovery From Power Failure: When a power failure occurs at the Central Station the system shall automatically start upon restoration of power as specified.

15.17 RCU Programming: The system shall include a programming function in the Central Station for a user to create, modify, and test programs for RCU RAM and PROM resident programs, constraints, and data base parameters for execution in RCU s of the same manufacturer. Capability shall be provided to accomplish:

a. Creation, modification, and testing programs. Modular application soft-ware, control sequences, and PI control loops shall be used in the development of programs.

b. Conversion of source programs into executable object code.

c. Editing source code.

d. Debugging operations.

e. Assignment of operational parameters resident in the RCU.

f. Save and retrieve source and executable object code.

g. Load RCU-RAM based information and programs into the RCU Portable Tester for loading directly into the RCU.

OCEGS-13952

AUGUST 1990

15.18 Central Station FND Standard Interface Adapter Software: Software shall be provided to meet all functional requirements of this specification for FND communications to each Island.

16. CENTRAL STATION, ISLAND STATION, AND RCU DATA COMMUNICATION REQUIREMENTS

16.1 FND Communication: FND communication shall be utilized between the Central Station and RCUs, between the Central Station and Island Station, and between the Central Station and any existing UEMCS in accordance with the AMEV FND Specifications. FND communication shall be provided for all points, functions, parameters and constraints identified by VDI-3814 and required by this specification.

16.1.1 FND communications between Central Station and RCUs and between Island Station and RCUs of the same manufacturer, shall also include:

a. Central Station and Island Station to RCU of all RAM resident software, operating parameters and constraints.

b. RCU to Central Station and Island Station of all RAM resident data, including parameters of connected systems and devices, constraints, and RAM resident software.

16.1.2 The operator shall be able to initiate a download of the disk file containing a copy of the RCU RAM-based software including data base from the Island Station to the RCU. After downline loading, the operator shall be able to initialize and start full operation of the RCU from the Central Station and from the Island Station. RCU parameter changes shall be performed with the RCU on-line.

16.2 Error Detection and Retransmission: A cyclic code error detection method shall be used between the Central Station and RCUs provided by the Contractor and between Island Stations and RCUs provided by the Contractor which shall detect all single and double bit errors, all burst errors of eight bits or less, and at least 99 percent of all other multibit and burst error conditions. Interactive or product error detection codes alone shall not be acceptable. Error detection in accordance with the AMEV FND Specifications shall be provided between the Central Station and RCUs, between the Central Station and Island Stations, and between the Central Station and existing UEMCS. A message shall be in error if one bit is received incorrectly. The system shall retransmit all messages with detected errors. A 2-digit decimal number shall be operator assignable to each communication link representing the number of retransmission attempts.

OCEGS-13952

AUGUST 1990

When the number of consecutive retransmission attempts equals the assigned quantity, the Central Station shall close down transmission to that particular device, and print an alarm message. The operator shall manually reopen any communications line after automatic closedown, subject to the same error checking and automatic closedown procedures in effect before the first automatic closedown. The system shall monitor the frequency of data transmission errors for display and logging. This may be accomplished by ancillary equipment or provided as an integral part of the primary system.

17. WIRE AND CABLE:

17.1 General: The Contractor shall provide all wire and cable. All wiring terminations to the DTCs shall utilize terminal connectors; bare wires shall not be connected to the DTC terminals.

17.2 Control Wiring:

17.2.1 Control wiring for digital functions shall be minimum diameter 0.8 millimeter with 600 volt insulation. Multiconductor wire shall have an outer jacket of polyvinylchloride (PVC).

17.2.2 Control wiring for analog functions shall be minimum diameter 0.8 millimeter with 600 volt insulation, twisted and shielded, 2, 3, or 4 wire to match analog function hardware. Multiconductor wire shall have an outer jacket of PVC.

17.3 Sensor Wiring: Sensor wiring shall be minimum diameter 0.8 millimeter, twisted and shielded, 2, 3, or 4 wire to match analog function hardware. Multiconductor wire shall have an outer jacket of PVC.

17.4 Low Energy Conductors: The conductor sizes specified for digital and analog functions shall take precedence over any requirements for low energy remote-controlled and signal circuit conductors specified elsewhere.

PART 3 EXECUTION

18. GENERAL:

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18.1 Installation: The Contractor shall install all system components and appurtenances in accordance with the manufacturer's instructions and shall provide all necessary interconnections, services,

OCEGS-13952

AUGUST 1990

and adjustments required for a complete and operable system. All wiring, including low voltage wiring, shall be installed in metallic raceways or PVC conduit as specified and shown. All other electrical and communications work shall be as specified in SECTIONInstrumentation and communications grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

18.2 I/O Summary Tables: The Contractor shall use the I/O summary tables in conjunction with other specified requirements to identify the hardware and software required.

19. EXISTING CONTROLS: The Contractor shall connect to and utilize existing local control loops and devices as specified. Control devices that are usable in their original configuration without modification may be reused. Sensors shall be new and shall be installed in addition to, not in place of, existing sensors and indicators except as specified. Existing local controllers which are specified to have new CPA ports added, or are to become dual input controllers, shall be replaced with new devices as specified. The Contractor shall perform a field survey, including testing and inspection of all existing devices and local control loops intended to be incorporated into the UEMCS and furnish a report. For those items considered nonfunctioning, provide (with the report) specification sheets, or written functional requirements to support the findings and the estimated cost to correct the deficiency. As part of the report, define the Contractor's scheduled need date for connection to all existing controls. The Contractor shall make written requests and obtain approval prior to disconnecting any controls and obtaining equipment downtime. Such work shall proceed only after receiving Government approval of these requests. If a local control loop or any device fails after the Contractor has commenced work on that loop or device, the Contractor shall diagnose the failure and perform any necessary corrections to the Contractor's equipment and work. The Government is responsible for maintenance and repair of Government equipment. The Contractor shall be held responsible for repair costs due to Contractor negligence or abuse of Government equipment.

(U)

20. EXISTING UEMCS: The Contractor shall provide FND transmission between the new UEMCS and existing UEMCS with existing FND Standard Interface Adapters as specified. The Contractor shall use the existing UEMCS data base information to generate the data base for the existing UEMCS points to be included in the Contractor's new UEMCS. The Contractor shall perform testing and inspection of the existing FND Standard Interface Adapter and the existing UEMCS data base and furnish a report. For those items which cannot be incorporated into the

OCEGS-13952

AUGUST 1990

Contractor's work, provide (with the report) specification sheets or written functional requirements to support the findings and the estimated cost to correct the deficiency.

21. INSTALLATION EQUIPMENT: The Contractor shall install all equipment as specified and required for an operational UEMCS.

21.1 Temperature Instruments:

21.1.1 RTDs: When the RTD is installed in pipes or is susceptible to corrosion and vibration, the RTD shall be installed in a thermowell. Thermowells shall be filled with conductive heat transfer fluid prior to installation of the RTD into the thermowell. RTDs used for space temperature sensing shall include a housing suitable for wall mounting. RTDs used for OA sensing shall have an instrument shelter to minimize solar effects, and shall be mounted to minimize building effects. RTD assemblies shall be readily accessible and installed in a manner to allow easy replacement.

21.1.2 Temperature Switches: Temperature switches shall be installed as specified for RTDs. Temperature switches shall be adjusted to the proper setpoint and shall be verified by calibration. Switch contact ratings and duty shall be selected for the application.

21.2 Relative Humidity Instrument: Relative humidity sensors shall have air guards when installed in air flows of more than 15 meters per minute across the sensor element.

21.3 Pressure Instruments:

21.3.1 Pressure Sensors: Pressure sensors (all types) installed on liquid lines shall have drains. Pressure sensors installed on steam lines shall have drains and siphons. All pressure sensors shall have valves for isolation, venting, and taps for calibration. Pressure sensors shall be verified by calibration. Differential pressure sensors shall have nulling valves.

(V)

21.3.2 Pressure Switches: Pressure switches (all types) installed on liquid lines shall have drains. Pressure switches installed on steam lines shall have drains and siphons. All pressure switches shall have valves for isolation, venting, and taps for calibration. Pressure switches shall be adjusted to the proper setpoint, and shall be verified by calibration. Pressure switches shall be mounted higher than the process connection. Differential pressure

OCEGS-13952

AUGUST 1990

switches shall have nulling valves. Switch contact ratings and duty shall be selected for the application.

21.4 Flow and Level Instruments:

21.4.1 Flowmeters: Flowmeters shall be installed in accordance with DIN 19208 through 19213.

21.4.2 Orifice Plates: Orifice plates shall be located in horizontal pipe runs for liquid flow measurement, and in vertical pipe runs unless otherwise shown for steam flow measurement. For liquid measurement, the orifice plate flanges shall be installed so that the pressure taps are in the horizontal plane with the centerline of the pipe. For gas measurement, the orifice plate flanges shall be installed so that the pressure taps are 45 degrees or more above the horizontal plane with the centerline of the pipe. For steam measurement in horizontal pipe runs, eccentric orifice plate flanges shall be installed so that the pressure taps are 45 degrees below, or in the horizontal plane with the centerline of the pipe. Orifice plates shall be installed for ease of accessibility for periodic maintenance. The differential pressure sensors shall be as close to the orifice plates as possible. For gas measurement the required differential pressure transmitter shall be physically installed above the orifice taps. For steam, the required differential pressure transmitter shall be physically installed a minimum of 20 centimeters below the taps. For liquid, the differential pressure transmitter shall be installed below the orifice taps.

21.4.3 Flow Nozzles: Flow nozzles shall be installed in horizontal pipe runs with flanges installed so that the pressure taps are in a horizontal plane with the centerline of the pipe. Flow nozzles shall be installed for ease of accessibility for periodic maintenance. The differential pressure sensors shall be installed as close to the flow nozzle as possible.

21.4.4 Venturi Tubes: Venturi tubes shall be installed in horizontal pipe runs for liquid flow measurement, and in vertical pipe runs for steam flow measurement. Venturi tubes shall be installed so that the pressure tap is in the horizontal plane with the centerline of the pipe. Venturi tubes shall be installed for ease of accessibility for periodic maintenance.

21.4.5 Annular Pitot Tubes: Annular pitot tubes shall be installed so that the total head pressure ports are set-in-line with the pipe axis upstream and the static port facing downstream. The total head pressure ports shall extend diametrically across the entire pipe.

OCEGS-13952

AUGUST 1990

Annular pitot tubes shall not be used wherever the flow is pulsating or where pipe vibration exists.

21.4.6 Turbine Meters: Turbine meters shall be installed so that the sensor is located in accordance with the manufacturer's instructions for the specified flow rates and installation conditions.

21.4.7 Vortex Shedding Flowmeters: The flowmeter shall be installed with its top above the pipeline in horizontal pipe run installations. The direction of flow shall be upward in vertical pipe run installations. The flowmeter shall be aligned to the direction of the flow, and shall be rigidly mounted and vibration free.

21.4.8 Flow Switches: Flow switches shall be installed in such a manner as to minimize any disturbance in the flow of fluid while maintaining reliable operation of the switch.

21.4.9 Liquid level switches: Level switches shall be installed in accordance with the manufacturers instructions. Switches shall be accessible for maintenance and calibration. In applications where switches cannot be directly mounted to a tank by the threaded or flanged connection, a mounting bracket shall be provided for connection to the inside tank wall.

21.4.10 Liquid Level Sensors: The sensing probes should be located close to, and parallel with, the tank wall.

21.4.11 Positive Displacement Flow Meters: Flow meters shall be installed horizontally, and in the direction of flow.

21.5 Electric Power Devices:

(W)

21.5.1 Potential and Current Transformers: The Contractor shall install potential and current transformers in new enclosures unless otherwise shown. Current transformer leads shall be shorted when they are not connected to the measurement circuits.

(W)

21.5.2 Watthour and Demand Meters: The Contractor shall install watthour and demand meters and transducers in new enclosures unless otherwise shown.

21.5.3 Current Sensing Relays: Relays shall be installed in new enclosures unless otherwise shown.

OCEGS-13952

AUGUST 1990

(W)

21.5.4 VAR Transducer: The VAR transducer shall be wired in accordance with the manufacturer's instructions, and installed in new enclosures unless other-wise shown.

(W)

21.5.5 PF Transducer: The PF transducer shall be wired in accordance with the manufacturer's instructions, and installed in new enclosures unless other-wise shown.

21.6 Output Devices:

21.6.1 Relays and Contactors: The Contractor shall install relays and contactors in new enclosures unless otherwise shown.

21.6.2 Electric Solenoid Operated Pneumatic Valve (EP): The Contractor shall install EPs in new enclosures unless otherwise shown.

(W)

21.6.3 Controllers: The Contractor shall install controllers in new enclosures unless otherwise shown.

21.6.4 Electric to Pneumatic (EP) Transducer: The Contractor shall install EP transducers in new enclosures unless otherwise shown.

21.7 Position Sensors:

21.7.1 End (Limit) Switch: Limit switch type and mounting shall be properly suited for the application to provide reliable switch operation.

21.7.2 Potentiometers: Potentiometer type and mounting shall be properly suited for the application to provide reliable operation.

21.8 Instrument Shelters: Instrument shelters shall be installed with the bottom 1.25 meters above the supporting surface using legs and secured rigidly to minimize vibrations from winds. Instrument shelters shall be oriented facing North.

21.9 Enclosures: All enclosure penetrations shall be from the bottom and shall be sealed to preclude entry of water using a silicone rubber sealant.

22. INSTALLATION SOFTWARE: The Contractor shall load all software as specified and required for an operational UEMCS, including data bases

OCEGS-13952

AUGUST 1990

(to include FND data bases for all points specified and shown), operational parameters, and system, command, and application programs. Upon successful completion of the Endurance Test, the Contractor shall provide original and backup copies of source (excluding the general purpose operating system and utility programs furnished by the computer manufacturers) and object modules for all software, on each type of media utilized. In addition, provide a copy on individual floppy disks of all software for each RCU.

(X)

23. MAINTENANCE AND SERVICE:

23.1 General Requirements: The Contractor shall provide all services required and equipment necessary to maintain the entire UEMCS in an operational state as specified for a period of 1 year after acceptance, and shall provide all necessary material required for the work. Impacts on facility operations shall be minimized when performing scheduled adjustments or other nonscheduled work.

23.2 Description of Work: The adjustment and repair of UEMCS includes all computer equipment, software updates, transmission equipment and DTM, RCUs and all new instrumentation and control devices. Responsibility shall be limited to the actual interface devices between the existing systems and the UEMCS, and all other equipment furnished as a part of the UEMCS. The Contractor shall perform the manufacturer's required adjustments and all other work necessary.

23.3 Personnel: Service personnel shall be qualified to accomplish all work promptly and satisfactorily. The Government shall be advised in writing of the name of the designated service representative, and of any changes in personnel.

23.4 Schedule of Work: The Contractor shall perform two minor inspections at 6-month intervals or less (if required by the manufacturer), and two major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude, and all work required as specified. Schedule major inspections in [June and December] [].

23.4.1 Minor Inspections: These inspections shall include:

a. Visual checks and operational tests of all Central Station equipment, Island Central Station equipment, peripheral equipment, interface panels and RCU hardware.

b. Fan checks and filter changes for all UEMCS equipment.

OCEGS-13952

AUGUST 1990

c. Mechanical adjustments, new ribbons, and other necessary adjustments on printers.

23.4.2 Major Inspections: These inspections shall include all work described under "Minor Inspections" and the following work:

a. Clean all Central Station and Island Station equipment, RCU hardware and interface panels including interior and exterior surfaces.

b. Perform diagnostics on all equipment.

c. Check and calibrate each field device. Check and calibrate 50 percent of the total analog points during the first major inspection. Check and calibrate the remaining 50 percent of the analog points during the second major inspection. Certify analog test instrumentation accuracy to be twice that of the device being calibrated. Adjust all control parameters and logic (virtual) points including control loop setpoints, gain constants, and integral constants for 50 percent of the total control loops during the first major inspection. Adjust control parameters and logic (virtual) points including control loop setpoints, gain constants, and integral constants for the remaining 50 percent of the control loops during the second major inspection. Randomly check at least 25 percent of all digital points in 50 percent of all buildings for operation during the first major inspection. Randomly check at least 25 percent of the digital points in the remaining buildings, during the second major inspection.

d. Run all system software diagnostics and correct all diagnosed problems.

e. Resolve any previous outstanding problems.

23.4.3 Scheduled Work: This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays.

23.5 Emergency Service: The Government will initiate service calls when the UEMCS is not functioning properly. Qualified personnel shall be available to provide service to the complete UEMCS. The Government shall be furnished with a telephone number where the service supervisor can be reached at all times. Service personnel shall be at the site within 24 hours after receiving a request for service. The control system shall be restored to proper operating condition within 3 calendar days after receiving a request for service.

OCEGS-13952

AUGUST 1990

23.6 Operation: Performance of scheduled adjustments and repair shall verify operation of the UEMCS as demonstrated by the applicable tests of the performance verification test.

23.7 Records and Logs: The Contractor shall keep records and logs of each task, and shall organize cumulative records for each major component, and for the complete system chronologically. A continuous log shall be maintained for all devices on a building-by-building basis. The log shall contain all initial analog span and zero calibration values and all digital points. Complete logs shall be kept and shall be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the UEMCS.

23.8 Work Requests: The Contractor shall separately record each service call request, as received. The form shall include the serial number identifying the component involved, its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. The Contractor shall deliver a record of the work performed within 5 days after work is accomplished.

23.9 System Modifications: The Contractor shall make any recommendations for system modification in writing to the Government. No system modifications, including operating parameters and control settings, shall be made without prior approval of the Government. Any modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected.

23.10 Software: The Contractor shall provide all software updates and verify operation in the system. These updates shall be accomplished in a timely manner, fully coordinated with UEMCS operators, and shall be incorporated into the operations and maintenance manuals and software documentation. There shall be at least one scheduled update near the end of the first year's warranty period, at which time the Contractor shall install and validate the latest released version of the Contractor's software.

GENERAL NOTES

1. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-720. It will not be made a part of a contract merely by reference; pertinent portions will be copied verbatim into the contract documents.

OCEGS-13952

AUGUST 1990

2. The capital letters in the right hand margins indicate that there is a technical note pertaining to that portion of the guide specifications. Delete the letters in the margins before typing the project specifications.

3. Where numbers, symbols, words, phrases, clauses, or sentences in this specification are enclosed in brackets [], a choice or modification must be made; delete inapplicable portions carefully. Where blank spaces occur in sentences, insert the appropriate data. Where entire paragraphs are not applicable, they shall be deleted completely. 4. This guide specification is intended for use within USAREUR.

TECHNICAL NOTES

A. The section number should be inserted in the specification heading and prefixed to each page number in the project specifications. This section will be used in conjunction with SECTION: ELECTRICAL WORK, INTERIOR; SECTION: ELECTRICAL-DISTRIBUTION AND STREET-LIGHTING SYSTEM, AERIAL; SECTION: ELECTRICAL-DISTRIBUTION AND STREET-LIGHTING SYSTEM, UNDERGROUND; SECTION: INTERCOMMUNICATIONS SYSTEMS; and any other guide specification sections required by the design.

B. Paragraph 1: The listed designations for publications are those that were in effect when the guide specification was being prepared. These designations are updated when necessary by Notice, and references in project specifications need be no later than in the current Notice for this guide specification. To minimize the possibility of error, the letter suffixes, amendments, and dates indicating specific issues should be retained in paragraph 1, and omitted elsewhere in the project specifications.

C. Paragraph 2.4: Specify sensor ranges and ratings for measurements, such as pressure and flow. Add requirements for additional site specific measurements, including span and accuracy for any special application not included in this specification.

D. Paragraph 2.6: The designer will provide adequate physical space within a normally occupied space for the Central Station and for each Island Station. The designer will not locate RCUs in boiler rooms or other areas subject to environmental extremes.

E. Paragraph 2.11: The designer will indicate the line side voltage and frequency available to the Contractor for the Central Station equipment, Island Stations, and each RCU. The designer will verify that power quality is satisfactory for the UEMCS hardware, and if there is insufficient quality, then provide a power line conditioner at the

OCEGS-13952

AUGUST 1990

Central Station, at each RCU, and at each Island Station. The designer will indicate the source (panel location and circuit number) of power for each power circuit the contractor must connect.

F. Paragraph 3: Depending on the local procurement laws and requirements, the acquisition of all technical data, databases and computer software items that are identified herein will be accomplished strictly in accordance with prevailing local procedures equivalent to the Federal Acquisition Regulation (FAR) and Department of Defense Acquisition Regulation Supplement (DOD FARS). Those regulations as well as the Army and Corps of Engineers implementations thereof should also be consulted to insure that a delivery of critical items of technical data is not inadvertently lost. Specifically, the Rights in Technical Data and Computer Software Clause, DOD FARS 52.227-7013, and the Data Requirements Clause, DOD FARS 52.227-7031, or other locally approved equivalents, as well as any requisite software licensing agreements will be made a part of the GENERAL CLAUSES or SPECIAL CLAUSES of the contract. In addition, the appropriate DD Form 1423 Contract Data Requirements List or equivalent will be filled out for each distinct deliverable data item and made a part of the contract. The designer will specifically identify the list of deliverable data, whether a DD Form 1423 or equivalent, in the text of Paragraph 3. Where necessary, a DD Form 1664 or equivalent Data Item Description, shall be used to explain and more fully identify the data items listed on the DD Form 1423. It is to be noted that all of these clauses and forms are required to assure the delivery of the data in question and that such data is obtained with the requisite rights to use by the Government. Include with the request for proposals a completed Contract Data Requirements List. This form is essential to obtain delivery of all documentation. Each deliverable will be clearly specified, both description and quantity being required.

G. Paragraph 3: Include a payment schedule in the SPECIAL CLAUSES with the request for proposals. This payment schedule will define payment milestones and percentages at specific times during the contract period.

H. Paragraphs 3.4.3, 3.5 and 5.1: The designer will select German language or other native language depending on locality. Unless the installation has a specific requirement otherwise, specify 2 copies of all manuals, except for the Operator's Manual, which should be specified to be 6 copies.

I. Paragraphs 6 and 18.1: The designer will include in the project specifications one or more of the following CEGS for the appropriate Data Transmission to be required at the project site: OCONUS WIRELINE DATA TRANSMISSION (CEGS-16788), and OCONUS TWO-WAY RADIO DATA

OCEGS-13952

AUGUST 1990

TRANSMISSION (CEGS-16799). The designer will include in the project specifications one or more of the following CEGS for the electrical work to be required at the project site: ELECTRICAL WORK, INTERIOR (CEGS-16415), ELECTRICAL DISTRIBUTION AND STREET LIGHTING SYSTEM, AERIAL (CEGS-16401), and ELECTRICAL DISTRIBUTION AND STREET LIGHTING SYSTEM, UNDERGROUND (CEGS-16402).

J. Paragraph 8.4.9: If severe motion in the tank is anticipated, the probes should be isolated by means of a stilling well.

K. Paragraphs 8.9, 8.10, 10.6, 13.9, 13.11.2.9, 15.9, and 15.11.4.11: The designer will coordinate the selection of German language or local native language Command Software, nameplates, and printer output with the installation.

L. Paragraph 9.1.3 Designer to always use DTM Specifications with or without cable, depending on availability of GFE.

M. Paragraph 10.14: I/O Summary Table will be incorporated into the contract package. Specify only those applications programs which are to be implemented at time of acceptance. Do not specify a program unless all sensors and controls required to implement it are included in the package.

N. Paragraph 10.14.2 and 10.14.5: The designer will specify all necessary load shed schedules required to implement the demand limiting program for all electrical loads plus all steam and hot water district heat loads. All demand limiting calculations will be directly correlatable to this family of load shed schedules. Load shed schedules will be identified specifically for each military installation or functional group. Provide a location for an Island Station, as some UEMCS manufacturers require an Island Station to coordinate demand limiting commands for multiple RCUs.

O. Paragraph 10.14.15 and 10.14.16: The designer will make the appropriate control parameter selections based on the installed equipment and operating requirements.

P. Paragraphs 11.1 and 14.3: The designer will specify the use of a circuitswitched (dial-up telephone) network or a packet-switched network such as DATEX P10 or DATEX P20 available from the Bundesposte, and coordinate the provision of the data communication service with the installation. DATEX P10 (which meets CCITT X.21 and X.25) is the standard network referenced in the AMEV FND Specifications. The designer will consult with Huntsville Division, CEHND-ED-ME, before utilizing any network other than DATEX P10.

OCEGS-13952

AUGUST 1990

Q. Paragraphs 12 and 13: The designer will locate Island Stations. This location will be coordinated with the Installation. The designer will specify Island Stations only if they are to be provided by the Contractor. Operator Interface Panels will be shown if Island Stations are not to be provided.

R. Paragraph 12.1.9 and 14.1.10: The designer will specify an additional 2-wire telephone circuit to support the Telephone modem specified.

S. Paragraph 13.12: If system graphics are desired at the Island Station monitor, add the following item to this paragraph: [d) System graphics for each system, with Real Time data.]

T. Paragraphs 14 and 15: The designer will specify the Central Station only if it is to be provided by the Contractor.

U. Paragraph 20: The designer will include in the I/O summary tables all I/O points in existing UEMCS which are to be included in the UEMCS Central Station data base for FND data exchange. The designer will verify the existence of an FND Standard Interface Adapter at each existing UEMCS "Island", or provide the FND Standard Interface Adapter(s) under a separate project or projects.

V. Paragraph 21.3.2: Specify where the switches are to be located and which type is to be used.

W. Paragraph 21.5.1, 21.5.2, 21.5.4, 21.5.5, and 21.6.3: The designer will specify individual potential and current transformers, watt-hour and demand meters and transducers, and controllers which are to be mounted in existing control cabinets. Unless these devices are specified to be mounted in existing cabinets, the supplier will be required to mount them in new cabinets.

X. Paragraph 23: The maintenance and service to be provided by the Contractor during first year's warranty period will be included as a separate bid item, and must be funded with O & M funds. The designer will coordinate funding requirements with the installation. END

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128

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